CADANGAN PENAWARAN PROGRAM AKADEMIK BARU
PROGRAM IJAZAH
SARJANA MUDA KEJURUTERAAN KIMIA DENGAN KEPUJIAN
FAKULTI KEJURUTERAAN
UNIVERSITI MALAYSIA SARAWAK

CADANGAN PENAWARAN PROGRAM AKADEMIK BARU

PROGRAM IJAZAH

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Bachelor of Chemical Engineering with Honours

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KANDUNGAN

1. TUJUAN

Kertas kerja ini bertujuan untuk memohon kelulusan Kementerian Pengajian Tinggi Malaysia (KPTM) mengenai cadangan menawarkan Program Ijazah Sarjana Muda Kejuruteraan dengan Kepujian (Kejuruteraan Kimia) di Fakulti Kejuruteraan (FK) bermula pada sesi akademik 2008/09. Cadangan penubuhan program tersebut telah diluluskan pada peringkat Jawatankuasa Perancangan dan Pembangunan Akademik (JPPA) Bil 04/2007 ke-82 pada 19 Jun 2007; Mesyuarat Senat Bil. 06/2007 ke-87 pada 26 Sept 2007; dan seterusnya Mesyuarat Lembaga Pengurusan Universiti Bil. 1/2008 ke-39 pada 21 Januari 2008.

2. PROGRAM AKADEMIK YANG DIPOHON

Ijazah Sarjana Muda Kejuruteraan Kimia dengan Kepujian.

Bachelor of Chemical Engineering with Honours.

3. FAKULTI YANG MEMOHON

Fakulti Kejuruteraan (FK).

3.1 Sejarah Penubuhan Fakulti

FK merupakan salah sebuah fakulti dari lapan buah fakulti yang ada di UNIMAS. Ia telah ditubuhkan pada 30 Disember 1993. Di awal penubuhan, FK telah menawarkan dua program pengajian iaitu Kejuruteraan Sivil dan Kejuruteraan Elektronik & Telekomunikasi. Pengambilan pertama pelajar adalah pada sesi akademik Julai 1994. Pada 1996, program Kejuruteraan Mekanikal & Pembuatan ditawarkan dan disusuli dengan penawaran program Kejuruteraan Elektronik & Komputer pada tahun 2000.

Rancangan penubuhan Program Kejuruteraan Kimia telah dikemukakan semasa penubuhan Fakulti Kejuruteraan 1993 lagi. Walaubagaimanapun, rancangan tersebut belum dapat direalisasikan disebabkan oleh pelbagai faktor, seperti kekurangan tenaga akademik serta kawasan kampus lama yang terhad.

Pada 18 April 2006, Kampus Baru UNIMAS yang juga dinamakan sebagai Kampus Barat UNIMAS telah dirasmikan oleh Perdana Menteri Malaysia Datuk Seri Abdullah Haji Ahmad Badawi. Kampus Baru UNIMAS tersebut juga dilengkapi dengan

infrastruktur yang disediakan khas untuk Jabatan Kejuruteraan Kimia. Ini termasuklah bilik-bilik pensyarah dan dua belas (12) makmal khas untuk program tersebut. Oleh yang demikian, program ini tidak akan menghadapi kesulitan dari segi infrastruktur sebab ianya telah siap dibina.

Merujuk kepada Mesyuarat Jabatan Kejuruteraan Kimia pada 8 Disember 2006 serta Perancangan Strategik Fakulti[1] pada 18-19 Disember 2006, pihak FK telah bersetuju supaya Jabatan Kejuruteraan Kimia ini diberi nama baru sebagai Jabatan Kejuruteraan Kimia & Sustainabiliti Tenaga (JKKST)[2]; manakala versi Inggerisnya ialah *Department of Chemical Engineering & Energy Sustainability (ChemES).*

3.2 Visi Fakulti

"Cemerlang dalam menawarkan program kejuruteraan berkualiti melalui sistem pendidikan yang dinamik dan inovatif, berkemahiran dalam bidang-bidang penyelidikan pengkhususan untuk manfaat negara".

(To be excellent in providing quality engineering programmes through dynamic and innovative education system, specialising in its niche research areas for the benefits of the nation).

3.3 Misi Fakulti

"Menyediakan sistem pendidikan kejuruteraan yang inovatif dan sistematik ke arah melahirkan jurutera yang beretika serta memiliki kemahiran teknikal dan interpersonal yang baik daripada warga fakulti yang pakar dalam bidang masing-masing, selaras dengan inspirasi *stakeholder* melalui rangkaian yang cemerlang."

(To provide innovative and systematic engineering education towards producing ethical engineers with good technical and interpersonal skills by faculty members renowned in their respective niche areas, thus, addressing the inspirations of the stakeholders through excellent networking).

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[1] Faculty of Engineering Strategic Planning Workshop, Pusat Latihan Bau, Bau, Sarawak, 18-19 December 2006

[2] Untuk laman web jabatan, sila rujuk alamat web: http://www.feng.unimas.my/

3.4 Objektif Fakulti

"Menjamin segala kegiatannya bersesuaian dengan perkembangan dan kemajuan teknologi baru dan akan datang, relevan dengan pembangunan Negara dan seiring dengan usaha meningkatkan taraf keikhtisasan bidangnya".

Semua ini dilaksanakan melalui penawaran pelbagai peluang dalam pendidikan kejuruteraan, latihan dan khidmat kesarjanaan serta melalui penerapan ilmu secara strategik dan inovatif bagi meningkatkan kualiti budaya bangsa dan kemakmuran masyarakatnya.

4. PERINGKAT PENGAJIAN

Ijazah Sarjana Muda dengan Kepujian.

5. TAHUN DIMULAKAN

Semester 1 Sesi 2008/09

6. JANGKA MASA PENGAJIAN DAN KAEDAH

Program pengajian adalah sepenuh masa, manakala tempoh pengajian adalah empat (4) tahun iaitu lapan (8) semester, manakala tempoh maksimum pengajian adalah enam (6) tahun iaitu dua belas (12) semester. Satu semester mengambil masa 14 minggu pembelajaran. Penilaian akademik pelajar-pelajar adalah dilakukan sepanjang semester dan gred-gred pencapaian dari tahun pertama pengajian sehingga tahun akhir pengajian akan diambilkira untuk menentukan pencapaian keseluruhan pelajar di akhir pengajian. Jangkamasa ini adalah mengikut sistem semester yang digunapakai di FK UNIMAS dan juga untuk memenuhi syarat-syarat kurikulum bagi pengiktirafan profesional di masa akan datang.

Kaedah kursus bagi program ini menggabungjalinkan kaedah syarahan, tutorial bersemuka, pembelajaran bersepadu, *mini problem based learning (mini PBL)*, makmal, latihan industri, projek rekabentuk dan projek tahun akhir.

Pendedahan kepada teori-teori serta asas bidang kejuruteraan kimia diberi penekanan khusus di dalam program ini. Di samping itu, pengetahuan kejuruteraan asas lain yang penting seperti mekanik bendalir, kejuruteraan kimia organik dan analitikal,

dan pengurusan tenaga dan alam sekitar turut diterapkan dalam silibus pengajaran dan pembelajaran berteraskan tenaga dan sumber-sumber asli.

Pada peringkat pertengahan dan akhir pengajian, pelajar-pelajar didedahkan dengan pengetahuan khusus seperti bidang keselamatan kejuruteraan, pengurusan alam sekitar, aspek pengurusan projek dan ekonomi, serta etika kejuruteraan. Pendedahan kepada alam pekerjaan dalam bidang kejuruteraan diterapkan dalam latihan industri. Pada tahun akhir pengajian, pelajar akan terlibat secara langsung dalam projek rekabentuk, pengendalian serta penulisan projek berasaskan bidang kejuruteraan kimia.

Kursus-kursus elektif ditawarkan pada peringkat akhir pengajian, di mana pelajar boleh memilih kursus untuk memperdalamkan lagi pengetahuan tentang bidang yang diminati.

7. JUSTIFIKASI PENAWARAN PROGRAM

Kejuruteraan kimia adalah satu bidang profesional yang penting di mana ia telah dikenalpasti sebagai pemangkin kepada aktiviti-aktiviti awam, swasta ataupun keperluan sektor-sektor industri kimia yang boleh menyumbang kepada ekonomi negara. Pada tahun 2010, negara memerlukan seramai 29,418 orang jurutera kimia[3]. Dengan adanya program ini, adalah diharapkan ia dapat menampung masalah kekurangan tenaga profesional dalam bidang yang kritikal ini.

7.1 Peranan UNIMAS Dalam Kecemerlangan Dan Perkembangan Pendidikan

Sebagai sebuah institusi pendidikan tinggi yang sudah mengecapi sedekad kecemerlangan, UNIMAS berhasrat untuk terus berperanan sebagai institusi yang aktif menyumbang kepada perkembangan pendidikan kebangsaan mahupun antarabangsa. Menyedari betapa pentingnya perkembangan profesionalisma dan keperluan tenaga kerja tersebut, FK berhasrat untuk menawarkan Program Ijazah Sarjana Muda Kejuruteraan dengan Kepujian (Kejuruteraan Kimia) ini sebagai usaha dan komitmen UNIMAS dalam menerajui kecemerlangan pendidikan.

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[3] Unit Perancangan Ekonomi (2006). Rancangan Malaysia Kesembilan 2006-2010. Unit Perancangan Ekonomi, Jabatan Perdana Menteri, Putra Jaya, 2006.

7.2 Keperluan Tenaga Kerja Dan Kepakaran

Menurut kajian pekerjaan Rancangan Malaysia Ke-9[4], negara kita pada tahun 2000, mempunyai seramai 2,888 orang jurutera kimia. Bilangan keperluan tenaga kerja dalam bidang kejuruteraan kimia ini dianggarkan meningkat kepada 29,418 orang pada tahun 2010. Ini menunjukkan pertumbuhan yang pesat dalam sektor yang berkaitan dengan kejuruteraan kimia. Dengan tertubuhnya JKKST pada 1 Julai 2006 dan perlancaran program ini yang dijangka bermula pada Sesi 2008/2009 adalah diharap UNIMAS dapat menyumbang kepada pembangunan sumber manusia dalam bidang ini dan menjadi salah sebuah institusi pengajian tinggi yang dapat melahirkan graduan dalam bidang kejuruteraan kimia untuk memenuhi keperluan tenaga kerja tersebut.

Baru-baru ini Kerajaan Negeri Sarawak telah mengumumkan penubuhan Projek Sarawak Corridor of Renewable Energy (SCORE)yang berpusat di sepanjang pantai dari Tanjung Manis ke Simulajau. Sehubungan dengan itu, pihak Kerajaan Negeri Sarawak, melalui Sarawak Planning Unit (SPU), menanggarkan keperluan jurutera seramai 2,970 orang setahun[5].

7.3 Sokongan Daripada Industri Dan Institusi-Institusi Pengajian Tinggi Awam (IPTA)

Pada peringkat awalnya, JKKST telah membuat perbincangan dengan beberapa pihak berkaitan dengan bidang kejuruteraan kimia. Antara pihak yang telah dibawa dalam perbincangan kurikulum ialah :-

(I) Industri.

i. Titan Chemical Corporation ; (ii) Sanmina-SCI
ii. Komag USA (M) Sdn (Sarawak Operation)
iii. Sejingkat Power Corporation Sdn. Bhd.
iv. Asean Bintulu Ferterlizer (ABF)

(II) IPTA.

i. Universiti Teknologi Malaysia (UTM)
ii. Universiti Malaya (UM)
iii. Universiti Putra Malaysia (UPM)

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[4] Unit Perancangan Ekonomi (2006). Rancangan Malaysia Ke-9 2006-2010. Unit Perancangan Ekonomi, Jabatan Perdana Menteri, Putra Jaya, 2006.
[5] State Planning Unit, Sarawak Corridor of Renewable Energy (SCORE), (2008).

Rumusan daripada perbincangan yang diadakan menunjukkan bahawa pihak industri dan IPTA menyokong sepenuhnya hasrat UNIMAS untuk menubuhkan program kejuruteraan kimia ini. Contohnya, pihak Titan Chemicals Corp memaklumkan bahawa 90% daripada jumlah yang bekerja di Titan Chemicals adalah jurutera kimia, malahan pihak mereka turut mengambil jurutera kimia dari luar negara.

Selanjutnya, dua perbincangan lanjutan dengan IPTA-IPTA dan pihak industri telah diadakan seperti berikut.

(a) 7 Mei 2008, The Legend Hotel Kuala Lumpur – satu perjumpaan khas dengan wakil-wakil IPTA-IPTA yang menawarkan program kejuruteraan Kimia. Antara yang hadir ialah :

i. Universiti Malaya
ii. Universiti Teknologi MARA
iii. Universiti Putra Malaysia
iv. Universiti Teknologi Malaysia
v. Universiti Kebangsaan Malaysia, dan
vi. Universiti Malaysia Pahang

Sila rujuk minit mesyuarat di Lampiran K. Wakil-wakil IPTA yang hadir bersetuju bahawa program yang ditawarkan adalah unik (Sustainabiliti Tenaga) dan tidak ditawarkan oleh IPTA-IPTA lain.

(b) 8 Mei 2008, Bilik Mesyuarat Fakulti, Fakulti Kejuruteraan, UNIMAS – satu perjumpaan khas dengan wakil-wakil dari industri yang berasaskan Kejuruteran Kimia khususnya yang berkaitan dengan SCORE telah diadakan. Antara yang hadir ialah :

i. Sarawak Planning Unit (SPU)
ii. Malaysia LNG Sdn Bhd
iii. Cahaya Mata Sarawak Sdn Bhd (CMS)
iv. Assar Chemical Industry Sdn Bhd
v. Accacia Cellulose International Sdn Bhd
vi. Similajau Industries Sdn Bhd
vii. Rio Tinto Aluminium Limited

Sila rujuk minit mesyuarat di Lampiran L. Mesyuarat bersetuju sepenuhnya bahawa program Kejuruteraan Kimia ini amat perlu ditawarkan bagi menyediakan tenaga kerja profesional dalam industri SCORE. Mesyuarat juga bersetuju bahawa program Kejuruteraan Kimia ini mesti ditawarkan pada sesi 2008/2009 bagi meyediakan tenaga kerja dalam industri-industri berkenaan.. Wakil-wakil industri yang hadir bersetuju bahawa penubuhan program Kejuruteraan Kimia di UNIMAS dijangka akan menyumbang keperluan tenaga kerja untuk industri-industri utama dalam SCORE mahupun industri-industri Kejuruteraan Kimia dan tenaga secara amnya. Di samping itu wakil industri-industri yang dijemput bersetuju memantau program Kejuruteraan Kimia dalam pengendalian latihan industri dan juga jalinan hubungan universiti – industri. Pandangan dari wakil-wakil industri telah diambil kira dalam pengelolaan program Kejuruteraan Kimia ini. Hasil daripada perbincangan tersebut, program Kejuruteraan Kimia akan membantu dalam menyediakan graduan-graduan untuk bekerja dalam industri utama dalam SCORE seperti di Annex 1 (Lampiran L).

7.4 Kakitangan Akademik

JKKST dijangka mempunyai lapan (8) orang staf pada permulaan program, diketuai oleh seorang Ketua Jabatan Dr. Haji Mohammad Omar Abdullah (perlantikan pada 1 Julai 2006, nombor rujukan UNIMAS/01-02/04.01 Jld 5 (116)). Daripada bilangan tersebut, tiga (3) orang sedang berkhidmat di bawah Jabatan Kejuruteraan Mekanikal dan Pembuatan. Dua (2) orang masih cuti belajar peringkat PhD dan seorang (1) orang melanjut pengajian sarjana. Senarai kakitangan akademik serta bidang pengkhususan masing-masing dan aktiviti-aktiviti penyelidikan staf adalah di Lampiran C. Dari segi fizikal, JKKST telah mempunyai staf yang berkelayakan tinggi dan akan ditambah lagi dengan pengambilan staf-staf baru untuk melancarkan program ini.

7.5 Kemudahan Infrastruktur

JKKST telah mempunyai infrastruktur yang siap dibina pada Projek Pembangunan Kampus Tetap UNIMAS Fasa I Peringkat I untuk tujuan pembelajaran dan pengajaran program kejuruteraan kimia. Antara ruang-ruang makmal yang sedia ada ialah:-

i Bilik Unit Operasi Kimia I (Fluids and Energy Transfer Operation Lab)

ii Bilik Unit Operasi Kimia II (Separation and Mass Transfer Operation Lab)

iii Bilik Instrumentasi dan Kawalan Proses (Instrumentation and Process Control Lab)

iv Bilik Teknologi Partikel (Particle Technology Lab)

v Bilik Kejuruteraan Alam Sekitar (Environmental Lab)

vi Bilik Bahan dan elektrokimia (Material and Electrochemistry Lab)

vii Bilik Kejuruteraan Bio-Kimia dan Gas Asli (Bio-chemical and Natural Gas Lab)

viii Bilik Termofluid dan Sustainabiliti Tenaga (Thermofluids dan Energy Sustainability Lab)

ix Bilik Komputer dan Simulasi (Computer and Simulation Lab)

x Bilik Bengkel Umum (General Workshop)

Sila rujuk Photo F1-F8 di Lampiran D. Penerangan lanjut mengenai bangunan infrastruktur dan bilik makmal sedia ada diberi di Bahagian 15.1. Perancangan asal Kampus Tetap UNIMAS sememangnya telah menampung keperluan fizikal untuk program kejuruteraan Kimia ini.

8. LATAR BELAKANG

Bidang kejuruteraan kimia merupakan bidang yang telah lama bertapak di negara kita sejak mencapai kemerdekaan. Ianya seiring dengan pertumbuhan industri kimia, minyak, gas, bijih timah dan sebagainya.

Kebanyakan industri tersebut menggunakan sebilangan tenaga jurutera dari luar negara disebabkan jurutera kimia tempatan adalah terhad. Ramai juruteknik industri berkelulusan diploma pula cuma mahir dalam bidang kerja penyelengaraan serta tidak berkesempatan untuk mendapat kursus lanjutan dalam kejuruteraan kimia bagi meningkatkan lagi mutu perkhidmatan masing-masing.

Di samping ilmu-ilmu kejuruteraan asas, program kejuruteraan kimia ini menjurus ke arah kepakaran yang khusus untuk kejuruteraan tenaga dan sumber-sumber asli yang banyak terdapat di negara kita. Sumber-sumber asli seperti minyak, gas, arang batu, minyak sawit, biokimia serta tenaga alternatif boleh diusahakan dan dimajukan lagi demi

manfaat negara. Masalah pengurusan tenaga dan pencemaran berhubung dengan sumber-sumber asli tersebut seperti pencemaran udara, air dan persekitaran lainnya memerlukan pengetahuan kejuruteraan yang terkini. Seiring dengan kemajuan pesat negara, semestinya lebih banyak jurutera kimia diperlukan untuk menampung kekurangan tenaga profesional tersebut.

Bagi menyahut cabaran terkini untuk menampung keperluan tersebut dan juga selari dengan misi UNIMAS untuk menjadi sebuah institusi pengajian tinggi pilihan utama pelajar dan ahli akademik, hasrat FK UNIMAS untuk menawarkan program ini adalah tepat pada masanya. Program ini dilihat mampu menyebarkan teori, praktikal dan pengetahuan terkini dalam bidang asas kimia mahupun bidang tertentu seperti yang telah dinyatakan.

Hasil pembelajaran yang dicadangkan adalah untuk menyediakan peluang graduan yang mempunyai keupayaan berikut:-

1. Berkebolehan untuk mendapatkan dan mengaplikasikan ilmu pengetahuan asas Kejuruteraan kimia.
2. Berkebolehan untuk berkomunikasi secara efektif bukan sahaja dengan para jurutera, malahan juga dengan pelbagai lapisan masyarakat.
3. Berpengetahuan tentang teknologi terkini dalam bidang kejuruteraan kimia.
4. Berkemahiran menggunakan alat-alat kejuruteraaan kimia dalam mengenalpasti masalah-masalah berkaitan dengan bidang kejuruteraan berkenaan serta dapat mencadangkan penyelesaian.
5. Berkebolehan merekabentuk fasiliti kejuruteraan kimia dengan mengaitkan elemen-elemen sustanabiliti – ekonomi, sosial, alam sekitar.
6. Berkeupayaan untuk bekerja secara individu, berkumpulan malahan boleh menjadi pemimpin/pengurus yang efektif.
7. Memahami tanggungjawab dan etika sebagai seorang jurutera profesional dalam aspek sosial, budaya, global, dan alam sekitar serta keperluan bagi pembangunan lestari.
8. Mempunyai kapasiti dan motivasi mengikuti pembelajaran sepanjang hayat (*life-long learning*).

9. Berkebolehan merekabentuk dan menjalankan ujikaji, serta mampu menganalisa dan mengintepretasikan data.
10. Berkebolehan dan berkemahiran dalam pelbagai tugasan.
11. Mempunyai pengetahuan tentang isu-isu semasa yang berkaitan dengan kejuruteraan kimia.

9. MATLAMAT PROGRAM

Matlamat program ini adalah untuk menyediakan bakal jurutera-jurutera dengan kebolehan yang cekap dan berkaliber dengan menghasilkan:

- Graduan yang mempunyai asas pengetahuan saintifik yang mantap dalam bidang kejuruteraan kimia dan bidang-bidang yang berkaitan mahupun teknologi yang terkini.

  (Graduates possess a strong foundation of scientific and technical knowledge in chemical engineering and related fields, as well as leading-edge technologies).
- Graduan yang berkebolehan untuk menyesuaikan diri di dalam karier mereka samada pada peringkat kebangsaan mahupun antarabangsa.

  (Graduates show adaptability in pursuing their career and be able to project themselves nationally and internationally).
- Graduan yang berkebolehan di dalam peninjauan, penggunaan serta di dalam kepelbagaian sumber-sumber asli untuk manfaat masyarakat tempatan

  (Graduates be able to explore, utilize and diversify natural resources for local community).
- Graduan yang berkebolehan di dalam memberi perkhidmatan di dalam sektor tenaga dan sektor yang berkaitan dengan alam sekitar.

  (Graduates be able in serving the energy and environmental related sectors).
- Graduan yang mempunyai kemahiran pemikiran yang tinggi bagi menguasai teknologi semasa yang terkini.

  (Graduates possess higher-order thinking skills necessary for utilizing contemporary technology).

10. KAJIAN PASARAN

Program ini ditawarkan adalah untuk menyediakan graduan sebagai jurutera yang bukan sahaja serba boleh dalam bidang kejuruteraan kimia malah mempunyai kelebihan dari segi pengetahuan terkini berkaitan dengan tenaga dan sumber-sumber asli serta alam sekitar. Pengetahuan tersebut adalah amat penting dalam kerjaya sebagai jurutera yang amat diperlukan oleh industri seperti berikut:

- Industri minyak dan gas, contohnya: Petronas, Shell dan MLNG.
- Industri pemprosesan, contohnya: Asean Bintulu Fertilizer (ABF), Titan Chemicals Corp Bhd, Austral Edible Oil Sdn. Bhd.
- Industri arang batu dan tenaga, contohnya: Sejingkat Power Coorperation
- Industri ringan, pemakanan, dan sebagainya, contohnya: Sofia Enterprise, Sadong Jaya.

Pasaran kerja yang berpotensi juga termasuk firma-firma perundingan dan institusi awam dan swasta. Tinjauan pasaran telah dijalankan dengan menggunakan dan mengedarkan borang soalselidik yang disediakan (Lampiran E). Maklumbalas kajiselidik yang penting adalah seperti berikut:

- 85% responden memberi maklumbalas yang memberangsangkan terhadap kualiti program yang bakal ditawarkan dan 100% bersetuju bahawa program yang akan ditawarkan setanding dengan program yang ditawarkan oleh universiti lain berdasarkan kursus yang ditawarkan.
- Hampir 94% responden bersetuju bahawa penawaran program ini akan memberikan impak yang baik terhadap masyarakat.
- Lebih kurang 70% responden menyetujui yang program ini akan dapat bertahan dalam jangka masa yang lama, "*Good long-term sustainability*".
- Kesemua 100% responden bersetuju program ini berpotensi untuk berkembang.
- 100% responden bersetuju yang bidang pengkhususan yang bakal ditawarkan adalah relevan dengan kehendak Negara dan SCORE (Sarawak Corridor of Renewable Energy).

Senarai syarikat-syarikat yang berkaitan dengan kejuruteraan kimia disertakan di jadual B-1 di Lampiran B.

Satu kajiselidik pendek *Short Industrial Survey* (sila lihat Lampiran E) telah dijalankan dengan mengedarkan borang kajiselidik kepada lebih kurang 70 buah syarikat yang berkaitan dengan kejuruteraan Kimia di Malaysia (Lampiran B, Jadual B-2). Daripada 13 responden yang telah diterima, kesemuanya (100%) telah bersetuju agar program ini dapat ditawarkan pada masa terkini; dan kesemuanya (100 %) bersetuju bahawa program ini akan mendapat sambutan untuk jangkamasa yang lama. Satu contoh responden yang begitu memberangsangkan (sila rujuk mesej email Encik Mokhtar Said daripada Syarikat Dynacraft di akhir Lampiran E) menyakinkan lagi bahawa program sedemikian akan berdaya saing dan berpotensi untuk ditawarkan.

11. STRUKTUR KURIKULUM

Untuk melayakkan seseorang pelajar itu dianugerahkan Ijazah Sarjana Muda Kejuruteraan dengan Kepujian (Kejuruteraan Kimia), pelajar mestilah dengan jayanya menamatkan program dengan memperolehi 130 jam kredit yang mengandungi kursus teras[6], kursus generik[5] dan kursus pelengkap[5] seperti berikut:

• Kursus Teras	107 jam kredit
• Kursus Generik	14 jam kredit
• Kursus Pelengkap	9 jam kredit
Jumlah	**130 jam kredit**

Kandungan kurikulum adalah berasaskan kepada pembangunan individu secara keseluruhan sebagai warga yang berautonomi tetapi saling bekerjasama dalam masyarakat. Kandungan program, kursus serta jam kredit adalah mengikut amalan yang diguna pakai oleh FK UNIMAS dan selaras dengan kehendak akreditasi.

Jadual 1(A) menunjukkan ringkasan kurikulum. Setiap semester mempunyai tujuh belas hingga lapan belas (17 - 18) jam kredit sahaja bagi kursus teras dan pelengkap; dengan latihan industri berjumlah enam (6) jam kredit ditawarkan pada Tahun 3 Semester 2. Kursus elektif yang ditawarkan diberi di Jadual 1(B).

[6] Huraian lengkap diberi di Bahagian 11.1

Berikut adalah jadual-jadual yang menerangkan kurikulum dengan lebih terperinci:

- Jadual 1(A) : Ringkasan kurikulum dari Tahun 1-4
- Jadual 1(B) : Kursus elektif yang ditawarkan

Struktur kurikulum tersebut mengandungi kursus-kursus kesemuanya berjumlah 130 jam kredit dan dirumus khas untuk memenuhi panduan yang digariskan oleh Majlis Akreditasi Kejuruteraan[7].

Jenis Kursus	Jam Kredit
Kursus Teras Kejuruteraan Kimia	80
Sains penggunaan,matematik, komputer, makmal dan bengkel	15
Latihan Industri, Projek Tahun Akhir	12
Kursus Pelengkap	9
Kursus Generik Universiti / Bahasa	14
Jumlah	130

Kursus elektif yang ditawarkan seterusnya ditunjukkan di Jadual 1(B). Pada permulaan, sebanyak (5) lima kursus akan ditawarkan kepada pelajar dimana kesemuanya berteraskan bidang tenaga dan sumber asli. Ianya akan memberi peluang kepada pelajar untuk menerokai bidang ilmu yang baru serta mendalami bidang yang dipilih. Antara kursus-kursus generik yang diambil oleh pelajar-pelajar UNIMAS dilampirkan pada Lampiran F.

[7] Engineering Accreditation Council (August 2005). Engineering Programme Accreditation Manual. 3rd Edition (2005).

Jadual 1(A): Ringkasan Kurikulum Tahun 1 - 4

TAHUN 1		YEAR 1

Tahun/Year 1 Semester 1

Kod (Code)	Kursus (Course)	Kredit (Credit)
KNC 1013	Mekanik Bendalir *Fluid Mechanics*	3
KNC 1022	Kejuruteraan Kimia Fizikal *Engineering Physical Chemistry*	2
KNC 1032	Lukisan Kejuruteraan *Engineering Drawing*	2
KNC 1042	Pengenalan Kepada Keseimbangan Bahan dan Haba* *Introduction to Materials and Heat Balance**	2
KNF 1013	Matematik Kejuruteraan I *Engineering Mathematics I*	3
KNF 1082	Pemprograman Kejuruteraan *Engineering Programming*	2
	Kursus Pelengkap - 1	3
	Jumlah (Total)	17

Tahun/Year 1 Semester 2

Kod (Code)	Kursus (Course)	Kredit (Credit)
KNC 1052	Kejuruteraan Kimia Organik *Engineering Organic Chemistry*	2
KNC 1063	Termodinamik I *Thermodynamics I*	3
KNC 1072	Ekonomi Kejuruteraan *Engineering Economics*	2
KNC 1082	Kejuruteraan Bahan *Engineering Materials*	2
KNC 1091	Amalan Bengkel *Workshop Practice*	1
KNC 1101	Makmal Kejuruteraan Kimia 1 *Chemical Engineering Laboratory I*	1
KNF 1023	Matematik Kejuruteraan II *Engineering Mathematics II*	3
	Kursus Pelengkap - 2	3
	Jumlah (Total)	17

**ditawarkan juga sebagai Kursus Pelengkap / also offer as Complementary Subject*

TAHUN 2	YEAR 2

Tahun/Year 2 Semester 1

Kod (Code)	Kursus (Course)	Kredit (Credit)
KNC 2112	Kimia Analitikal *Analytical Chemistry*	2
KNC 2122	Pengenalan Kepada Pemindahan Haba dan Jisim *Introduction to Heat and Mass Transfer*	2
KNC 2133	*Termodinamik II* Thermodynamics II	3
KNC 2142	Kejuruteraan Alam Sekitar* *Environmental Engineering*	2
KNC 2151	Makmal Kejuruteraan Kimia 2 *Chemical Engineering Laboratory 2*	1
KNF 2033	Matematik Kejuruteraan III *Engineering Mathematics III*	3
	Kursus Pelengkap - 3	3
	Kursus Generik - 1	2
	Jumlah (Total)	**18**

Tahun/Year 2 Semester 2

Kod (Code)	Kursus (Course)	Kredit (Credit)
KNC 2162	Unit Operasi Kimia I *Chemical Unit Operations I*	2
KNC 2173	Proses Pemindahan *Transport Process*	3
KNC 2182	Keselamatan dan Kesihatan Pekerja *Occupational Safety and Health*	2
KNC 2193	Proses Pengasingan dan Teknologi Partikel *Separation Process and Particle Technology*	3
KNC 2202	Proses Instrumentasi *Instrumentation Process*	2
KNF 2053	Kaedah Numerikal dan Statistik *Numerical Methods and Statistics*	3
	Kursus Generik - 2	2
KNC 2211	Makmal Kejuruteraan Kimia 3 *Chemical Engineering Laboratory 3*	1
	Jumlah (Total)	**18**

* *ditawarkan juga sebagai Kursus Pelengkap / also offer as Complimentary Subject*

TAHUN 3	YEAR 3

Tahun/Year 3 Semester 1

Kod (Code)	Kursus (Course)	Kredit (Credit)
KNC 3223	Unit Operasi Kimia II Chemical Unit Operations II	3
KNC 3233	Sistem Kawalan Proses Process Control System	3
KNC 3243	Proses Tindak Balas Kimia Chemical Reactions Process	3
KNC 3253	Rekabentuk Proses Process Design	3
KNC 3262	Polimer Untuk Aplikasi Tenaga Polymer for Energy Applications	2
	Kursus Generik – 3	2
	Kursus Generik - 4	2
	Jumlah (Total)	**18**

Tahun/Year 3 Semester 2

Kod (Code)	Kursus (Course)	Kredit (Credit)
KNF 3066	Latihan Industri *Industrial Training*	6
	Jumlah (Total)	**6**

TAHUN 4	YEAR 4

Tahun/Year 4 Semester 1

Kod (Code)	Kursus (Course)	Kredit (Credit)
KNC 4273	Sumber Tenaga dan Aplikasi *Energy Resources and Applications*	3
KNC 4283	Kawalan Kualiti & Keboleharapan *Quality Control & Reliability*	3
KNC 4294	Rekabentuk Loji Kimia *Chemical Plant Design*	4
KNC 4301	Makmal Kejuruteraan Kimia 4 *Chemical Engineering Laboratory 4*	1
KNC 4312	Projek Tahun Akhir I *Final Year Project I*	2
KNF 4073	Pengurusan Kejuruteraan *Engineering Management*	3
	Kursus Generik - 5	2
	Jumlah (Total)	**18**

Tahun/Year 4 Semester 2

Kod (Code)	Kursus (Course)	Kredit (Credit)
KNC 4324	Projek Tahun Akhir II *Final Year Project II*	4
KNC 4332	Pengurusan Tenaga dan Alam Sekitar *Energy and Environmental Management*	2
KNF 3102	Etika Kejuruteraan *Engineering Ethics*	2
KNC 4XX3	Kursus Elektif I *Elective Course I*	3
KNC 4XX3	Kursus Elektif II *Elective Course II*	3
	Kursus Generik - 6	2
	Kursus Generik - 7	2
	Jumlah (Total)	**18**

Jadual 1(B): Kursus Elektif*

Kod (Code)	Kursus (Course)	Kredit (Credit)
KNC 4343	Biodiesel dan *Fuel Cell* untuk Pengangkutan *Biodiesel and Fuel Cell for Transportation*	3
KNC 4353	Tenaga-Bio *Bio-energy*	3
KNC 4363	Kejuruteraan Rawatan Air dan Air Sisa *Water and Wastewater Treatment Engineering*	3
KNC 4373	Kejuruteraan Gas Asli *Natural gas engineering*	3
KNC 4383	Sustainabiliti dalam Industri Tenaga *Sustainability in energy industry*	3

* Pelajar dikehendaki memilih 2 kursus sahaja; pada tahun empat (4) semester dua.

11.1 Takrif dan Huraian Struktur Kurikulum

- **Kursus Teras**: ialah kursus-kursus yang memberikan pengetahuan dan kemahiran ke arah pengkhususan dalam sesuatu bidang atau lapangan yang perlu dikuasai oleh seorang jurutera kimia.

- **Kursus Generik**: ialah kursus-kursus yang bertujuan untuk memupuk sikap positif disamping memberi kemahiran pengurusan diri. Kedua-dua aspek pembangunan kognitif (motivasi, kreativiti, estetika, dan lain-lain) dan afektif (nilai, etika, sosial, dan lain-lain) diberi perhatian. Kursus Generik juga memberikan penekanan kepada kebolehan kemahiran-kemahiran analitis, berkomunikasi dan teknologi maklumat. Pelajar diasah supaya mahir berdwibahasa (Bahasa Melayu dan Inggeris) serta digalakkan mempunyai pengetahuan dalam bahasa ketiga.

- **Kursus Pelengkap**: ialah kursus-kursus pilihan antara Fakulti yang memberi peluang kepada pelajar untuk mendalami satu bidang lain, terutamanya yang berkaitan dengan bidang pengurusan sumber tenaga dan sumber asli.

- **Latihan Industri:** Pada tahun ketiga iaitu pada semester kedua, para pelajar diwajibkan menjalani Latihan Industri selama 16 minggu[8]. Tujuan latihan industri, antara lain, adalah untuk mendedahkan pelajar-pelajar kepada pengalaman dan pengetahuan kejuruteraan kimia yang bersesuaian dan juga kegiatan-kegiatan penyelidikan yang tidak terdapat dalam bilik kuliah. Di samping itu, melalui latihan industri ini pelajar-pelajar juga dapat menyesuaikan diri dengan alam pekerjaan yang akan ditempuh selepas tamat pengajian kelak.

- **Projek Tahun Akhir:** Pada tahun keempat (4), pelajar diwajibkan mengambil ketiga-tiga kursus yang ditawarkan, iaitu Projek Rekabentuk Loji Kimia (KNC 4294), Projek Tahun Akhir 1(KNC 4312) dan Projek Tahun Akhir 2 (KNC 4324). Bagi

[8] Buku Panduan Pelajar (2006). Buku Panduan Pelajar Fakulti Kejuruteraan Sesi 2006/2007. Universiti Malaysia Sarawak. Mukasurat 5.

kursus KNC 4294, para pelajar dibahagikan mengikut kumpulan dan diwajibkan menyiapkan projek rekabentuk loji kimia. Penilaian akan dilakukan berdasarkan laporan serta juga pembentangan cadangan projek. Manakala, bagi kursus KNC 4312 dan KNC 4324, para pelajar dikehendaki menjalankan kajian secara individu. Pelajar diberi kebebasan untuk memilih tajuk yang bersesuaian, biasanya berkaitan dengan industri, dibawah penyeliaan staf-staf akademik. Melalui Projek Tahun Akhir, para pelajar bukan sahaja dapat mempraktikan apa yang telah dipelajari malah akan menguasai kemahiran berkomunikasi dan kemahiran kejuruteraan yang lain.

- **Kursus Elektif:** Pada tahun keempat (4), para pelajar juga dikehendaki memilih dua (2) kursus pengkhususan daripada senarai kursus elektif yang ditawarkan di Jadual 1(B). Bidang pengkhususan yang dicadangkan adalah yang berteraskan kepada teknologi dan sumber-sumber tenaga serta sustainabiliti, merangkumi pengurusan dan pencemaran alam sekitar berhubung sumber-sumber tenaga tersebut .

11.2 Penilaian dan Peperiksaan

Sistem penilaian yang disarankan oleh pihak Universiti ialah sistem yang menggalakkan interaksi antara pensyarah dan pelajar. Keberkesanan sistem ini adalah bergantung kepada penyertaan secara aktif. Dalam proses pembelajaran yang fleksibel ini, penilaian yang berterusan akan menggalakkan para pelajar untuk membangun dengan cemerlang dalam pelajaran. Markah yang diperolehi, selain dari peperiksaan akhir, akan bergantung kepada pencapaian pelajar di dalam penyediaan projek, kuiz, seminar, ujian kelas, dan sebagainya sepanjang semester.

11.3 Sistem Pemarkahan dan Gred

Penilaian kursus yang ditawarkan oleh UNIMAS adalah berpandukan kepada skala gred seperti di Jadual 2 berikut:

Jadual 2: Sistem pemarkahan dan gred[9]

<table>
<tr><th rowspan="2">Gred</th><th rowspan="2">Julat Markah (%)</th><th rowspan="2">Nilai Gred</th><th colspan="2">Taraf Pencapaian</th></tr>
<tr><th>Kursus Teras</th><th>Kursus Generik/Pelengkap</th></tr>
<tr><td>A</td><td>80-100</td><td>4.00</td><td colspan="2" rowspan="2">Lulus Cemerlang</td></tr>
<tr><td>A-</td><td>75-79</td><td>3.67</td></tr>
<tr><td>B+</td><td>70-74</td><td>3.33</td><td colspan="2" rowspan="2">Lulus Kepujian</td></tr>
<tr><td>B</td><td>65-69</td><td>3.00</td></tr>
<tr><td>B-</td><td>60-64</td><td>2.67</td><td colspan="2" rowspan="3">Lulus Baik</td></tr>
<tr><td>C+</td><td>55-59</td><td>2.33</td></tr>
<tr><td>C</td><td>50-54</td><td>2.00</td></tr>
<tr><td>C-</td><td>45-49</td><td>1.50</td><td rowspan="2">Gagal</td><td rowspan="2">Lulus Lemah</td></tr>
<tr><td>D</td><td>40-44</td><td>1.00</td></tr>
<tr><td>F</td><td>< 40</td><td>0.00</td><td colspan="2">Gagal</td></tr>
</table>

Berpandukan Jadual 2 di atas, Gred C- dan ke bawah (iaitu 49% dan ke bawah) dianggap gagal bagi semua Kursus Teras. Manakala bagi kursus generik/pelengkap markah kurang daripada 40% dianggap gagal.

12. ETIKA DAN KEMANUSIAAN

Program Pengajian Kejuruteraan Kimia adalah berdasarkan kepada etika-etika yang berikut:

12.1 Tanggungjawab Terhadap Pelajar

Semua aktiviti yang dirancang dalam program ini adalah bertujuan untuk mengembangkan potensi pelajar dalam bidang akademik, sosioemosi dan pembentukan sahsiah diri tanpa mengira latar belakang agama, jantina, keupayaan fizikal dan tahap sosioekonomi mereka. Untuk memastikan tujuan ini tercapai, setiap tenaga pengajar program ini bertanggungjawab terhadap perkara yang berikut:

- Tidak mengabaikan pengajaran kepada mana-mana pelajar dan memastikan mereka diberi peluang yang sama rata untuk terlibat dalam kesemua aktiviti pengajaran dan pembelajaran.

[9] Bahagian Pengajian Siswazah (2006). Peraturan Akademik Pengajian Ijazah Sarjana Muda. Universiti Malaysia Sarawak, Mukasurat 13.

- Tidak memberikan keistimewaan kepada mana-mana pelajar dalam apa jua hal yang berkaitan dengan pengurusan program dan proses pengajaran-pembelajaran.
- Tidak menyalahgunakan kuasa yang diberi sebagai tenaga pengajar untuk tujuan tertentu yang boleh mendatangkan masalah kepada pelajar dalam apa bentuk sekalipun.
- Tidak mengabaikan kepercayaan pelajar dengan melakukan perkara-perkara yang boleh membawa aib kepada maruah pelajar atau menyentuh isu-isu sensitif dan peribadi.
- Menjaga kebajikan pelajar sepenuhnya dengan berperanan sebagai mentor dan rakan akademik yang boleh mendengar dan membantu menyelesaikan masalah secara profesional dan tidak prejudis.

12.2 Tanggungjawab Terhadap Profesion

Keputusan yang dicapai dalam apa jua perbincangan berkaitan dengan tadbir urus dan perjalanan program mesti selari dengan matlamat dan falsafah pendidikan Negara. Pihak pengurusan program dan tenaga pengajar merupakan pendukung amanah masyarakat untuk memastikan setiap pelajar yang mengikuti program ini akan dapat menyumbang kepada kemajuan masyarakat dan membawa Negara ke arah kegemilangan pendidikan. Oleh itu, menjadi tanggungjawab semua pihak yang terlibat dalam program ini untuk:

- Menjalankan aktiviti pengajaran yang tidak bertentangan dengan falsafah pendidikan Negara serta menghilangkan kepercayaan masyarakat dan pelajar terhadap institusi pendidikan Negara.
- Mempergiatkan aktiviti penyelidikan dan pencarian ilmu baru serta peka kepada penemuan baru dalam bidang penyelidikan.
- Tidak menyalahgunakan pengaruh untuk kepentingan persendirian.

12.3 Tanggungjawab Terhadap UNIMAS

Pengurusan dan perjalanan program ini tertakluk kepada Akta Universiti dan Kolej Universiti (pindaan) 1996, serta peraturan akademik yang telah ditetapkan oleh UNIMAS.

13 UNJURAN PELAJAR

Jadual 3 menunjukkan unjuran pelajar untuk tempoh lima (5) tahun akademik. Angka ini adalah dianggap optimum berdasarkan kepada makmal dan bangunan sedia ada serta bilangan akademik yang dijangka berkhidmat. Untuk setiap tahun pengajian, nisbah staf:pelajar akan ditentukan dalam julat 1:6-8. Ini adalah selaras dengan kriteria akreditasi Majlis Akreditasi Kejuruteraan.

Jadual 3: Unjuran pelajar untuk lima (5) tahun.

Sesi Pengambilan	Jumlah Pelajar		Jumlah Staf Akademik			Nisbah Pelajar : Staf
	Pengambilan	Keseluruhan	JKKST	Fakulti	Keseluruhan	
Sesi 2008/2009	30	30	5	1	6	1:5
Sesi 2009/2010	50	80	10	2	12	1:7
Sesi 2010/2011	80	160	20	3	23	1:7
Sesi 2011/2012	100	260	30	3	33	1:8

14 SYARAT-SYARAT KEMASUKAN

Syarat-syarat kemasukan ke program ini adalah seperti di Jadual 4.

Jadual 4: Syarat-syarat kemasukan menurut syarat am universiti dan keperluan khas program.

Syarat Am Universiti	Lulus Sijil Pelajaran Malaysia (SPM)/Setaraf dengan mendapat kepujian dalam mata pelajaran Bahasa Melayu/Bahasa Malaysia atau kepujian Bahasa Melayu/Bahasa Malaysia kertas Julai. **dan** Lulus matrikulasi KPM/Asasi Sains UM/Asasi UiTM dengan mendapat sekurang-kurangnya PNGK 2.00 ; **atau** Lulus Peperiksaan Sijil Tinggi Pelajaran Malaysia (STPM) dengan mendapat sekurang-kurangnya gred C (NGMP 2.00) dalam mata pelajaran Am dan gred C (NGMP 2.00) dalam dua mata pelajaran lain **dan** Mendapat sekurang-kurangnya Tahap 1 (Band 1) dalam Malaysian Universiti English Test (MUET).

Keperluan Khas Program	Mendapat sekurang-kurangnya Gred B- (2.67) pada peringkat Matrikulasi / Asasi dalam matapelajaran berikut: • Matematik/Matematik Kejuruteraan, • Fizik/Kejuruteraan Fizik, • Kimia/Kejuruteraan Kimia, **dan** Mendapat sekurang-kurangnya kepujian pada peringkat SPM dalam matapelajaran berikut: • Matematik/Matematik Tambahan, • Bahasa Inggeris/Bahasa Inggeris 1119 **atau** Mendapat sekurang-kurangnya kepujian Gred B (NGMP 3.00) pada peringkat STPM dalam mata pelajaran berikut: • Fizik, • Matematik Tambahan dan • Biologi/Kimia. **atau** Memperolehi sekurang-kurangnya Gred B dalam A-level bagi matapelajaran berikut: • Matematik • Fizik dan, • Kimia **dan** Mencapai skor 550 dalam *Test of English as a Foreign Language* (TOEFL) atau mencapai 6.0 dalam *International English Language Testing Services* (IELTS).
Calon Kelayakan Setaraf	Memiliki kelulusan Diploma Kejuruteraan Kimia dengan mendapat PNGK sekurang-kurangnya 2.67 atau kelulusan lain yang diiktiraf setaraf dengannya oleh Kerajaan Malaysia dan diluluskan oleh Senat IPTA.
Keperluan Lain	Calon *tidak* rabun warna. Ini memudahkan pelajar untuk membezakan warna pH atau larutan kimia yang berwarna dengan baik.

15 IMPLIKASI FIZIKAL, KEWANGAN DAN STAF (2006-2012)

15.1 Implikasi

Kemudahan-kemudahan sedia ada ialah Bangunan JKKST yang terdiri daripada bilik syarahan, bilik makmal dan bilik komputer. Dari segi prasarana, JKKST telah bersedia sembilan puluh (90%) peratus bangunan-bangunan yang diperlukan. Oleh itu, kemudahan tambahan yang diperlukan bagi tempoh lima (5) tahun hanyalah:-

- Peralatan makmal.
- Komputer & perisian.

15.2 Implikasi Kewangan

15.2.1 Kos Kelengkapan dan Bahan

Anggaran kos kelengkapan dan bahan berjumlah RM 5.37 juta untuk tahun pertama penawaran program. Ianya banyak melibatkan keperluan asas untuk menyediakan kursus-kursus makmal yang ditawarkan. Kos tersebut adalah untuk pembelian peralatan makmal bagi Kejuruteraan Kimia.

Untuk jangkamasa lima tahun, anggaran keseluruhan kos kelengkapan dan bahan dijangka berjumlah RM 20.273 juta. Ini termasuk kos-kos peralatan penyelidikan dan penambahan alat-alat untuk kursus-kursus makmal. Sila rujuk Jadual 5 untuk keperluan kelengkapan dan bahan untuk tempoh lima (5) tahun, 2008-2012.

Jadual 5: Anggaran Kos kelengkapan dan bahan untuk tempoh lima (5) tahun, 2008-2012.

Perkara	2008	2009	2010	2011	2012
Alat pengajaran & penyelidikan (aset pembangunan) -A33000	5 Juta	5 Juta	3 Juta	2 Juta	2 Juta
Bekalan bahan penyelidikan & pengajaran (inventori) -27798	100,000	130,000	170,000	220,000	280,000
Pakai habis -27799	100,000	130,000	170,000	220,000	280,000
Alat pengajaran (lesen perisian, computer, notebook, dan lain-lain)	170,000	219,000	275,000	354,000	455,000
Jumlah	5,370,000	5,479,000	3,615,000	2,794,000	3,015,000
				Total	**20.273 Juta**

15.2.2 Kos Pengurusan dan Staf Baru

Bagi kos pengurusan pula, anggaran minima yang diperlukan cuma **RM 110,000** setiap tahun. Implikasi kos pengurusan adalah minima memandangkan FK sudah mempunyai empat (4) program sedia ada di bawah naungan satu Fakulti. Oleh itu kos pengurusan boleh diselaraskan bersama.

Jadual 6: Kos Pengurusan

Jenis Kos Pengurusan	Jumlah (RM)
Perjalanan Dalam Negeri	30,000
Persidangan	15,000
Syarahan Sambilan	60,000
Keraian	5,000
Jumlah	**110,000**

Pengambilan kakitangan akademik dan sokongan baru akan dilakukan secara berperingkat-peringkat. Sebahagian daripada tenaga pengajar terdiri daripada pensyarah yang mengajar kursus-kursus Fakulti seperti Matematik, Etika Kejuruteraan, Pemprograman, dan lain-lain. Keperluan staf-staf akademik dan sokongan bagi JKKST adalah seperti tertera di Jadual 7. Mengikut perancangan sedia ada, keperluan staf akademik dan staf sokongan akan mencapai tahap optima pada tahun 2010.

Jadual 7: Keperluan staf-staf akademik dan sokongan.

Kategori Staf Akademik	2007	2008	2009	2010
Profesor /Profesor Madya	-	1	2	1
Pensyarah	1	6	3	5
Tutor	-	0	3	4
Pertambahan	-	7	8	10
Jumlah	**1**	**8**	**20**	**30**
Kategori Staf Sokongan				

Pembantu Teknik	-	1	-	-
Pembantu makmal	-	1	1	-
Juruteknik	-	6	3	2
Kerani Program	1	-	-	-
Pertambahan	-	8	4	2
Jumlah	**1**	**9**	**13**	**15**

16 PROGRAM AKADEMIK YANG SEDANG DITAWARKAN DI FAKULTI YANG MEMOHON

Berikut adalah program akademik Sarjana Muda Kejuruteraan yang sedang ditawarkan di FK:

- B.Eng dengan Kepujian Kejuruteraan Sivil
- B.Eng dengan Kepujian Kejuruteraan Mekanikal & Pembuatan
- B.Eng dengan Kepujian Kejuruteraan Elektronik (Telekomunikasi)
- B.Eng dengan Kepujian Kejuruteraan Elektronik (Komputer)

17 PERTINDIHAN PROGRAM YANG DIPOHON DENGAN IPT LAIN

Senarai IPTA Malaysia yang menawarkan program Ijazah sarjana muda kejuruteraan dengan Kepujian (Kejuruteraan Kimia) atau ijazah yang hampir serupa ditunjukkan di jadual G1, Lampiran G. Di samping IPTA, beberapa institut pengajian tinggi swasta (IPTS) turut menawarkan ijazah sarjana muda kejuruteraan kimia, contohnya, Curtin University of Technology, Miri, Sarawak dan The University of Notingham Malaysia Campus (Jadual G2, Lampiran G).

Di samping menjalankan program Ijazah Sarjana Muda Kejuruteran Kimia, kebanyakkan universiti-universiti tersebut juga menjalankan program-program kejuruteraan kimia yang lebih khusus, contohnya:

- Biokimia dan bioproses: UMP, UTM, USM, UiTM.
- Teknologi Gas: UTM, UMP dan UTP.
- Kimia alam-sekitar: UM, USM, The University of Notingham Malaysia Campus.

- Polimer: UTM.
- BioPerubatan: UM.
- Proses Pengasingan dan Pemangkin: USM

Begitu juga dengan universiti di luar negara (Jadual G3, Lampiran G). Terdapat universiti tertentu yang menawarkan program kejuruteraan kimia tambahan yang lebih khusus, contohnya Loughborough University di UK dan MIT di USA. Bagaimanapun, kebanyakan universiti lazimnya menawarkan hanya Ijazah Sarjana Muda Kejuruteraan/Sains Kimia tanpa pengkhususan.

Jadual G4 di Lampiran G menunjukkan pertindihan kursus dengan 9 IPTA tempatan dan 4 buah universiti luar negara. Pada dasarnya, kursus-kursus dalam program di institusi-institusi tersebut sememangnya mempunyai pertindihan dari segi asas pembelajaran, namun terdapat isi kandungan dan sukatan kursus-kursus tertentu di UNIMAS berbeza dari universiti-universiti tersebut. Keutamaan matlamat program (PEO) bagi JKKST, kursus-kursus berhubung dengan sumber tenaga dan sustainabiliti tenaga dan alam sekitar telah diberi penekanan khusus dengan perkembangan ilmu dan teknologi pendidikan serta teknologi industri global dewasa ini.

18 KEAHLIAN DAN ULASAN LEMBAGA PENGAJIAN TERHADAP PROGRAM YANG DIPOHON

18.1 Ahli Lembaga Pengajian:

Pengerusi:

Prof. Madya Dr. Wan Hashim Wan Ibrahim	-	Dekan, Fakulti Kejuruteraan, Universiti Malaysia Sarawak.

Ahli Dalaman:

Dr. Hj. Mohammad Omar Abdullah	-	Ketua Jabatan Kejuruteraan Kimia & Sustainabiliti Tenaga, Universiti Malaysia Sarawak

Ahli Luar (IPTA):

Prof. Madya Dr. Ezzat Chan Abdullah	-	Ketua Jabatan Kejuruteraan Kimia, Universiti Malaya
Prof. Madya Dr. Sharifah Aishah Syed Abdul Kadir	-	Dekan, Fakulti Kejuruteraan Kimia, Universiti Teknologi MARA
Prof. Madya Dr. Robiah Yunus	-	Ketua Jabatan Kejuruteraan Kimia, Universiti Putra Malaysia
Prof. Dr. Zainuddin Abdul Manan	-	Wakil Ketua Jabatan Kejuruteraan Kimia, Universiti Teknologi Malaysia
Prof. Ir. Dr. Abdul Wahab Mohammad	-	Timbalan Dekan Akademik, Fakulti Kejuruteraan, Universiti Kebangsaan Malaysia
Prof. Madya Dr. Zulkafli Hassan	-	Timbalan Dekan, Fakulti Kejuruteraan Kimia dan Sumber asli, Universiti Malaysia Pahang

Ahli Luar (Industri):

Mr. Mohd. Aris Yusof	-	General Manager, Assar Chemical Industries, Sejingkat, Kuching
Mr, Mohd Yatim Hassan	-	Manager, Human Resource Develeopment and Training, Malaysia LNG Sdn. Bhd, Bintulu, Sarawak
Mr. Mortadza bin Mohsen	-	Manager, Accacia Cellulose International Sdn. Bhd, Kuching, Sarawak
Mr. Rhyn Ng	-	Project Manager, Similajau Industries Sdn. Bhd, Kuching, Sarawak
Mr. John Reeve	-	Study Director, Rio Tinto Aluminium Limited, Kuching Sarawak
Mr. Edward Suka	-	Human Resources and Administration Manager, CMS Cement Sdn Bhd, Kuching.

Mr. Julien Alen	-	Assistant Director, State Planning Unit, Chief Minister's Department, Sarawak

18.2 Ulasan Dan Minit Mesyuarat Lembaga Pengajian

Ulasan dan minit mesyuarat lembaga pengajian terhadap program yang dipohon dilampirkan seperti di Lampiran K dan Lampiran L.

19 TARIKH PROGRAM DILULUSKAN

Program ini telah mendapat kelulusan di Peringkat Jawatankuasa Perancangan dan Pembangunan Akademik (Mesyuarat JPPA Bil 04/2007 ke-82 pada 19 Jun 2007), Lembaga Pengajian IPTA (7 Mei 2008) dan Lembaga Pengajian Industri (8 Mei 2008), Senat (Mesyuarat Senat Bil. 06/2007 ke-87 pada 26 Sept 2007) dan seterusnya Lembaga Pengurusan Universiti (Mesyuarat LPU Bil. 1/2008 ke 39 pada 21 Jan 2008).

20 KESIMPULAN/SYOR

Program ini berhasrat untuk melengkapkan pelajar dengan segala asas kejuruteraan Kimia yang kukuh; serta berkebolehan untuk menangani segala masalah-masalah interdisiplin secara cekap yang berasaskan kimia dan tenaga. Program ini dijangka dapat membantu menjayakan pembangunan sumber manusia negara bagi keperluan Wawasan 2020 serta SCORE melalui program akademik yang relevan yang dapat memantapkan kemampuan negara mengurus sumber asli, tenaga dan alam sekitar secara mampan. Dengan itu, Kementerian Pendidikan Tinggi Malaysia (JKPT) adalah dengan hormatnya diminta memperakukan program Sarjana Muda Kejuruteraan Kimia dengan Kepujian di Fakulti Kejuruteraan, UNIMAS.

Lampiran A
Sokongan daripada IPTA

LAMPIRAN A
SOKONGAN DARIPADA IPTA: *UTM EXPERTS' MEETING* 16-18 OGOS 2006 DAN MAKLUM BALAS DARI IPTA.

Tiga orang pakar Fakulti Kejuruteraan Kimia dan Sumber Asli, UTM telah melawat UNIMAS pada 16-18 Ogos 2006 bagi membantu menasihat dan memeriksa silibus akademik serta di dalam perancangan keperluan makmal. Mereka adalah:

1. Prof Madya Dr. Zainuddin Abdul Manan - Ketua Jabatan Kej Kimia
2. Prof Madya Dr. Kamarul Asri Bin Ibrahim - Timbalan Dekan (Akademik)
3. Prof Madya Dr.Hanizam Sulaiman - Pakar Program Baru/Makmal

Photo 1. Lawan jam daripada atas: PM Dr. Hanizam, PM Dr. Kamarul Asri, PM Dr. Zainuddin, Cik Norfamila, Dr. Hj. Mohammad Omar and PM Dr. Ng Chee Khoon.

Photo 2. Gambar berkumpulan selepas tamat mesyuarat dan diskusi, 18 Ogos 2006.
Tempat: Bilik Perbincangan, Fakulti Kejuruteraan, UNIMAS.

"Dr Robiah Yunus" <robiah@eng.upm.edu.my>

01/12/2007 10:24 AM

To <amomar@feng.unimas.my>

cc

bcc

Subject Re: Memohon pendapat mengenai penubuhan program kejuruteraan kimia

History: This message has been forwarded.

I support such program because in the future, we will be reducing our intake
for the program due the changes in our focus to research university.

Assoc. Prof. Dr Robiah Yunus
Head,
Department of Chemical and Environmental Engineering,
Faculty of Engineering.
Universiti Putra Malaysia.
603-89466268 - tel
603-86567120 - fax

----- Original Message -----
From: <amomar@feng.unimas.my>
To: <pejsktm@ums.edu.my>; <wakcm@usm.my>; <engdean@vlsi.eng.ukm.my>; <kka@eng.upm.edu.my>; <engine@iiu.edu.my>; <ezzat@um.edu.my>
Sent: Thursday, January 11, 2007 9:57 PM
Subject: Memohon pendapat mengenai penubuhan program kejuruteraan kimia

> Assalamualikum,
>
> Dear Datuk/Dato'/Prof./Dr,
>
> We had just recently setup a department, Chemical Engineering & Energy
> Sustainability Department, at the Faculty of Engineering, UNIMAS. Now, the
> department intend to come up with a program, Ijazah Sarjana Muda
> Kejuruteraan dengan Kepujian (Kejuruteraan Kimia),scheduled to commence in
> July 2007 this year. With your expertiest and experiences, we would be
> most
> grateful therefore, if you could kindly advise us on the feasibility of
> such program. For the mean time, we would be most obliged if you could
> kindly stated whether you are supporting to such program or not.
>
> Your simple answar to this initial communication would be very much
> appreciated.
>
>
> Thank you very much in advance,
>
>
> With kind regards,
>
>
> OMAR
>
>
> Dr. Hj. Mohammad Omar Abdullah, Member ASHRAE, CEng, MIMechE (UK)
> Head of Chemical Engineering & Energy Sustainability Department
> (Lecturer of Mechanical & Manufacturing Engineering Department, and

> Chemical Engineering Department)
> Faculty of Engineering
> Universiti Malaysia Sarawak
> 94300 Kota Samarahan
> Sarawak
> Malaysia.
>
> Tel: +60 82 583338 (direct line)
> Fax: + 082-583409
> Email: amomar@feng.unimas.my
>
>
>
>
>
> --
> No virus found in this incoming message.
> Checked by AVG Free Edition.
> Version: 7.1.410 / Virus Database: 268.16.9/623 - Release Date: 1/11/2007
>
>

"Ezzat Chan"
<ezzat@um.edu.my>
01/12/2007 10:19 AM

To <amomar@feng.unimas.my>
cc
bcc
Subject RE: Memohon pendapat mengenai penubuhan program kejuruteraan kimia

Wa alaikumus salam Dr Omar;

Thank you for the invitation. I have no problem with this. Regards.
Wassalam.

ezzat chan

-----Original Message-----
From: amomar@feng.unimas.my [mailto:amomar@feng.unimas.my]
Sent: 11 Januari 2007 21:57
To: pejaktm@ums.edu.my; wakcm@usm.my; engdean@vlsi.eng.ukm.my; kka@eng.upm.edu.my; engine@iiu.edu.my; ezzat@um.edu.my
Subject: Memohon pendapat mengenai penubuhan program kejuruteraan kimia

Assalamualikum,

Dear Datuk/Dato'/Prof./Dr,

We had just recently setup a department, Chemical Engineering & Energy Sustainability Department, at the Faculty of Engineering, UNIMAS. Now, the department intend to come up with a program, Ijazah Sarjana Muda Kejuruteraan dengan Kepujian (Kejuruteraan Kimia),scheduled to commence in July 2007 this year. With your expertiest and experiences, we would be most grateful therefore, if you could kindly advise us on the feasibility of such program. For the mean time, we would be most obliged if you could kindly stated whether you are supporting to such program or not.

Your simple answar to this initial communication would be very much appreciated.

Thank you very much in advance,

With kind regards,

OMAR

Dr. Hj. Mohammad Omar Abdullah, Member ASHRAE, CEng, MIMechE (UK)
Head of Chemical Engineering & Energy Sustainability Department
(Lecturer of Mechanical & Manufacturing Engineering Department, and Chemical Engineering Department)
Faculty of Engineering
Universiti Malaysia Sarawak
94300 Kota Samarahan
Sarawak
Malaysia.

Tel: +60 82 583338 (direct line)
Fax: + 082-583409

Wan Ahmad Kamil Che Mahmoo
<wakcm@usm.my>
01/15/2007 12:23 PM

To amomar@feng.unimas.my
cc
bcc
Subject Re: Memohon pendapat mengenai penubuhan program kejuruteraan kimia

Prof.

Mohon maaf kerana bidang kejuruteraan kimia agak berbeza daripada bidang kimia(Pusat Pengajian Sains Kimia di USM). Walaubagaimana pun, PPSK di USM ada menawarkan ijazah BAppSc dalam bidang Kimia Industri. Terdapat beberapa kertas dan kursus yang mendedahkan pelajar terhadap pemprosesan dan kimia persekitaran. Sekian.

Assoc. Prof. Dr. W.A. Kamil Mahmood
Dean
School of Chemical Sciences
Universiti Sains Malaysia
11800 USM, Penang
Tel: +604-6533262; +604-6560462 (DL)
Fax: +604-6574854

----- **Original Message** -----

From: amomar@feng.unimas.my

Date: Thursday, January 11, 2007 9:57 pm

Subject: Memohon pendapat mengenai penubuhan program kejuruteraan kimia

> Assalamualikum.
>
> Dear Datuk/Dato'/Prof./Dr.
>
> We had just recently setup a department, Chemical Engineering & Energy
> Sustainability Department, at the Faculty of Engineering, UNIMAS.

LAMPIRAN B
Sokongan Daripada Industri

INDUSTRIAL STAKEHOLDER'S MEETINGS

Gambar 1: Taklimat daripada Dekan FK sebelum perbincangan dalam *Stakeholder Meetings*.

Gambar 2: Gambar berkumpulan bersama *stakeholders* di UNIMAS, Kuching, 9 Ogos 2006.

Gambar 3: Taklimat daripada Dr. Hj. Mohammad Omar Abdullah mengenai borang *stakeholder* selepas *syllabus presentation* di Hotel Park City Avely, Bintulu, Sarawak, 24 Ogos 2006.

Jadual B-1. Senarai syarikat-syarikat pilihan yang dijemput untuk perbincangan di FK, UNIMAS.

- Assar Chemicals Sdn. Bhd.
- Austral Edible Oil Sdn. Bhd.
- B.I.G Industrial Gas Sdn. Bhd.
- Cahaya Mata Sarawak Bhd
- Chemsain Konsultant Sdn. Bhd
- Combitec Plastic Industries Sdn Bhd
- Felda Palm Industries Sdn. Bhd.
- FFM Flour Mills (Sarawak) Sdn Bhd
- Golden Priority Sdn Bhd: food processing& packaging
- Hexza-Nestle Chemicals Sdn Bhd : chemicals
- Hexzachem Sarawak Sdn Bhd
- Kimia Utama Sdn Bhd: Agricultural chemicals
- Jayabumi Timur Sdn Bhd: seawage treatment equipment
- Komag USA (M) Sdn Bhd.
- Kong Long Huat Chemicals Sdn Bhd: chemicals
- Lam Soon (M) Sdn Bhd: vegetable oils
- Malaysia LNG Sdn. Bhd.
- Pawada Food Industries Sdn Bhd
- Pembinaan Jayabumi (Sarawak) Bhd: seawage treatment equipment
- Professional Energy (M) Sdn Bhd: boiler
- Sarawak Shell Berhad
- Sanmina SCI Corporation (M) Sdn. Bhd.
- Sarawak Oil Palms Bhd
- Sekitar Ceria Enviromental Services Sdn. Bhd.
- Taiyo Yuden (Sarawak) Sdn Bhd.
- Tesway (M) Sdn Bhd: chemicals
- Trans-Ocean Coatings & Chemicals Sdn. Bhd.
- Water Genesis Sdn Bhd
- Wee & Wee Trading Sdn Bhd: fertilizers wholesale & manufacturers
- Wee Me e Industries Co. Sdn Bhd: food products.
- Yung Kong Galvanising Industries Bhd
- 1st Silicon (M) Sdn Bhd

Jadual B-2. Senarai syarikat-syarikat pilihan yang telah diedarkan borang *Feedback Survey Form (Short Industrial Survey)*

- Colgate-Palmolive (Malaysia) Sdn Bhd.
- Exxonmobil Subsidiaries In Malaysia
- Golden Hope Plantations Berhad
- ICI Paints (Malaysia) Sdn Bhd
- Intel Technology Sdn Bhd
- Komag USA (M) Sdn Bhd
- Kumpulan Guthrie Berhad
- Malakof Berhad
- Molex (Malaysia) Sdn Bhd
- Pecd Berhad
- Shell Malaysia
- Sime Darby Berhad
- Sunway Group
- Technip Geoproduction (M) Sdn Bhd
- Continental Sime Tyres Sdn Bhd
- Petroliam Nasional Bhd
- (Petronas)
- Tenaga Nasional Berhad
- Edaran Otomobil Nasional Berhad
- Infineon Technologies (Malaysia) Sdn Bhd.
- Nestle (Malaysia) Berhad
- Schlumberger Wta (M) Sdn Bhd
- Roche (Malaysia) Sdn Bhd
- Sanmina Sci Corporation (M) Sdn. Bhd.
- Taiyo Yuden (Sarawak) Sdn. Bhd.
- Faber Medi-Serve Sdn Bhd.
- TA Ann Plywood Sdn Bhd
- Jabatan Kerja Raya,
- Assar Chemicals Sdn Bhd.
- CMS Cement Sdn Bhd
- AZZAIR Sdn Bhd
- Perodua Manufacturing Sdn Bhd
- Malaysia LNG Sdn. Bhd.
- Asian Bintulu Fertilizer Sdn Bhd
- NEC Semiconductor (M) Sdn Bhd
- Flextronics Technology (Malaysia) Sdn Bhd.
- Epsilon Jurutera Perunding (S) Sdn. Bhd.
- Sejingkat Power Corporation Sdn Bhd
- Dynacraft Industries Sdn Bhd.
- Fuji Seat (Malaysia) Sdn Bhd.
- Perbadanan Pembekalan Lektrik Sarawak (SESCO)
- CMS Cement Sdn Bhd.
- Sarawak Plantations Services Sdn. Bhd.

- Sharp Manufacturing Corporation (M) Sdn Bhd
- CHIYODA (M) Sdn Bhd
- SGC Industries Malaysia Sdn Bhd
- Aluminium Metal Bersatu Sdn Bhd
- Silterra Malaysia Sdn BHd
- Agilent Technologies Malaysia Sdn. Bhd.
- Carrier International Sdn. Bhd.
- Motorola Technology Sdn. Bhd.
- MLS Precision Eng Sdn. Bhd.
- LNLT (Far East) Berhad
- Texas Instruments Malaysia Sdn Bhd
- Balda Thong Fook Solutions Sdn Bhd.
- Malaysia Airlines
- Proton Berhad
- Yung Kong Galvasing Industries Bhd.
- Samling Plywood (Baramas Sdn. Bhd.)
- Pioneer Technology (M) Sdn Bhd.
- Syn Nam Ee Sdn Bhd.
- Toko Electronics (Sarawak) Sdn. Bhd.
- Cahya Mata Sarawak Bhd.
- OMG Fidelity (M) Sdn. Bhd.
- Fortune Wide Sdn. Bhd.
- Alom Trading Sdn. Bhd.
- Alpha Ultimate Sdn. Bhd.
- SEM (M) Sdn. Bhd.
- Polyclad Laminates Kuching Sdn. Bhd.
- Weida Integrated Industries Sdn. Bhd.
- Faber Mediserve Sdn. Bhd.
- Nestle Manufacturing (M) Sdn. Bhd.
- Hexza-Nestle Chemicals Sdn. Bhd.
- Kimia Utama
- Malaysian Pepper Board, Malaysia
- Hanna Instruments (M) Sdn Bhd

Lampiran C

Senarai Kakitangan Akademik Serta Bidang Pengkhususan dan Aktiviti-aktiviti Penyelidikan Staf

LAMPIRAN C
Senarai Kakitangan Akademik serta bidang pengkhususan

	Name	Bachelor	Master	PhD	Remarks
1	Dr. Hj. Mohammad Omar Abdullah	B.Eng (Hons) (Petroleum Engineering) (UTM)	MEng (Petroleum)(drilling fluid) (UTM)	Ph.D. (Mechanical Engineering & Manufacturing) (UH)	PhD in hybrid fuel cell & solar for air conditioning (UK), 2002Energy resources and applications, including fuel cell, green fuel, solar thermal energy & air-conditioning.
2	Dr. Rubiyah Baini	BEng (Hons)(Chemical & Process Engineering)(UKM)	MSc Eng (Process Safety & Loss Prevention)(Sheffield)	PhD (Chemical Eng.)	PhD in drying (University of Sydney, Australia)
3	Nazeri Abd Rahman	BSc (Hons)(Petroleum and Natural Gas Engineering)(NMT)	MSc (Thermal Power and Fluid Engineering)(UMIST)	-	PhD in energy sustainability (UK) (2008, near completion). Now in UNIMAS
4	Dr. Abu Saleh Ahmed	BEng (Hons)(Mechanical, Bangladesh)	MSc (Mechanical Engineering) (UM)	PhD (Kyoto University) (Japan)	PhD in Bio-energy (Kyoto University, Japan)
5	Norfamila Bt Che Mat	B.Eng (Hons) (Material Science and Engineering) (Kyushu . U)	MSc (Process Engineering), UNSW	-	Biodegradable polymer research (Japan). Polymer research for energy applications e.g. photovoltaic. Completed MSC Chemical Eng in Feb 2008
6	Noraziah binti Abdul Wahab	B.Eng (HONS) in Chemical Engineering (Edinburgh, UK)	MBA in Project Management (USQ, Australia)	-	Currently Studying M.ENG (Energy & Environment) at UNIMAS in the area of fuel cell and wastewater treatment.

					Expected completion June 2008.
7	Magdalene Andrew Munot	BEng (Hons)(Chemical & BioProcess Eng.)(Bath, UK)	MSc (Manufacturing System Engineering)(UPM)	-	PhD in manufacturing (Australia) (on study leave since 2005)
8	Shanti Faridah	BEng (Chemical Engineering)(Loughborough, UK)	MSc (Chemical Engineering)(Leeds)	-	PhD in biomass (UKM) (Study leave since December 2006)

Aktiviti-aktiviti Penyelidikan Staf yang berkait-rapat dengan Pengajaran

Penyelidikan staf kejuruteraan kimia adalah di dalam peringkat awal di JKKST ini. Kursus pengajaran dan kerja penyelidikan adalah direkabentuk sebegitu rupa di mana kedua-duanya saling bersangkut-paut di antara satu sama lain. Selari dengan matlamat dan bidang pengkhususan Jabatan, bidang utama yang diceburi oleh staf JKKST ialah bidang kejuruteraan Kimia yang berhubung rapat dengan tenaga dan sumber asli yang berkaitan dengan sumber tenaga. Antara bidang/tajuk penyelidikan yang sedang dijalankan oleh staf JKKST ialah seperti berikut:

Bidang/tajuk penyelidikan:

(a) Fuel cell technology.
(b) Biofuel teknologi.
(c) Penggunaan *solar and exhaust heat* dan pembinaan automobile *air-conditioning unit.*
(d) Solar thermal transient study.
(e) Solar drying for crops.
(f) Biomass technology.
(g) Water and waste water treatment using fuel cell and local microbial technology.
(h) Sustainability and study of rural alternative energy applications, contoh rujukan.
(i) Polymer research for energy application,eg. for photovoltaic application.
(j) District cooling system using compression assisted with ice ball thermal cooling.
(k) Ammonia-water absorption refrigeration.
(l) Environmental Imact Assessment of chemical plants.
(m) Green fuel and fuel combustion catalyst.
(n) Stress-corrosion cracking of industrial ammonia tank.
(o) Lain-lain.

Rujukan:

I-Journals:

1. M.O. Abdullah and Y.K.Gan. Feasibility study of a mini fuel cell to detect interference from a cellular phone. *Journal of Power Sources*. 155 (2006) 311-318 **(Impact Factor = 3.521)**.

2. S. Watanabe, A. A. Saleh, S. P. Pack, N. Annaluru, T. Kodaki, and K. Makino, Protein engineering of xylose reductase from Pichia stipitis for improved NADH-specificity and the efficient ethanol production from xylose in recombinant Saccharomyces cerevisiae, Journal of Microbiology, 2007, 153, pp. 3044-3054 **(Impact Factor: 3.139)**

3. S. Watanabe, A. A. Saleh, S. P. Pack, N. Annaluru, T. Kodaki, and K. Makino, Ethanol Production from Xylose by Recombinant *Saccharomyces cerevisiae* Expressing Protein Engineered NADP+-Dependent Xylitol Dehydrogenase, *Journal of Biotechnology*, 2007, 130.3, pp. 316-319 (**Impact Factor: 2.60**)

4. N. Annaluru, A. A. Saleh, S. Watanabe, S. P. Pack, T. Kodaki and K. Makino, Thermostabilization of *Pichia stipitis* xylitol dehydrogenase by mutation of structural zinc binding loop, *Journal of Biotechnology*, 2007, 129.4, pp. 712-22 (**Impact Factor: 2.60**)

5. Baini, R. & Langrish, T.A.G. (2007). Choosing an appropriate drying model for intermittent and continuous drying of bananas, *Journal of Food Engineering, 79(1), 330 – 343* (**Impact Factor: 1.696**).

6. Baini, R. & Langrish, T.A.G. (2008). An Assessment of the Mechanisms for diffusion in the Drying of Bananas, *Journal of Food Engineering, 85(2), 201 – 214* **Baini, R.** & Langrish, T.A.G. (2007). Choosing an appropriate drying model for intermittent and continuous drying of bananas, *Journal of Food Engineering, 79(1), 330 – 343* (**Impact Factor: 1.696**).

7. M.O. Abdullah, F.A. Mikie and C.Y. Lam. Drying performance and thermal transient study with solar radiation supplemented by forced-ventilation. *International Journal of Thermal Sciences*, Volume 45, Issue 10, October 2006, Pages 1027-1034 Available online 28 February 2006. (**Impact Factor = 0.991).**

8. S. Watanabe, A. A. Saleh, S. P. Pack, N. Annaluru, T. Kodaki, and K. Makino, The Positive Effect of the Decreased NADPH-preferring activity of Xylose Reductase from *Pichia stipitis* on the Ethanol Production Using Xylose-fermenting Recombinant *Saccharomyces cerevisiae*, *Journal of Bioscience, Biotechnology and Biochemistry*, 2007, pp. 1365-9

9. M.O.Abdullah, F.S. Bhinder & M.O Sabri. Combined Flash-vaporisation and Solar Evacuated Tube Heat-Driven Absorption Air Conditioning System for the Tropic. IEM Journal. Institution of Engineers, Malaysia. Volume 68, No.2, June 2007. Page 20-27.

10. Yassin, A.A., Kamis, A. and Abdullah, M.O. (1991), "Formulation of an environmentally save (palm-diesel) oil-based drilling fluid" *Society of Petroleum Engineers (SPE) Technical Papers* Microfiche No. 23001. Ann Arbor, Michigan.

11. Mohamed Sutan, N., Baini, R., & Awang Aemeran, D. Z. (2003). Safety procedure for bridge inspection in Sarawak, Malaysia, *Pakistan Journal of Applied Sciences, Science Publications*, Vol 3(1), 1 - 3.

12. A. A. Saleh, S. Watanabe, N. Annaluru, T. Kodaki, and K. Makino, Construction of Various Mutants of Xylose Metabolizing Enzymes for Efficient Conversion of Biomass to Ethanol, *Nucleic Acids Symposium Series (Oxford Journal)*, 2006, 50, pp. 279-280

II- Patents

1. M.O Abdullah and S. L Leo. 2007. Heat Driven Adsorption Air-Conditioning System for Automobile. File reference: 070873 mba/js. Worldwide patents pending.

III- International conference

1. M.O. Abdullah and S.L. Leo. Feasibility of solar adsorption technologies for automobile air conditioning. Proceeding of ASME/ISEC2005, 2005 International Solar Energy conference, August 6-12, 2005, Orlando, Florida, USA.

2. Mohammad Omar Abdullah, Voon Chun Yung, Audra Anak Jom, Alvin Yeo Wee, Martin Anyi, khairuddin B Ab. Hamid, Johh Tarawe and James Tarawe, Energy Sustainability Study of a Rural ICT Telecenter at the Bario Highland, Paper No. ES2007-36061, presented at the Energy Sustainability 2007 Conference (ES2007), June 27-30, 2007, Long Beach, California, USA. Proceedings of the 2007 ASME Energy Sustainability 2007 Conference (ES2007), ISBN 0-7918-3798-X, Order No. 1765CD.

3. N. Abdul Rahman, Dr. S. M. Haile and Dr. P. Norman, Power Generations and Other Alternative Utilisations from Palm Oil Mills Waste,, In Proceeding: Design and Manufacture for Sustainable Development, 4th International Conference, University of Newcastle upon Tyne, England, 12-4 July 2005.

4. N. Abdul Rahman, Dr. S. M. Haile and Dr. P. Norman, Potential and Barriers to the Implementation of Sustainable Biomass Electricity Generation For Tiger Prawn Aquaculture: A Case Study at Samarahan Division, Sarawak, Malaysia, In Proceeding: World Bioenergy 2004: Conference and exhibition on Biomass for Energy, Elmia Convention Centre, Jönköping, Sweden, 2-4 June 2004. pp 147.

5. Baini, R., & Langrish, T.A.G. (2004). Drying kinetics of banana. *32nd Australasian Chemical Engineering Conference*, 26 – 29 September, Sydney, Australia. Paper on CDROM.

6. M.O. Abdullah & C.H. Tang, H2O-NH3–H2 Absorption Refrigeration: Thermodynamics Investigations by Experimentation and Modeling. Paper presented at the 12th Asian Chemical Congress (12ACC) August 23-25, 2007, PWTC, Kuala Lumpur.

IV- Local conference

1. C. Jourbert, P.N.Y.Yek, M.O.Abdullah, E. Junaidi, S. Hamdan, A. Rahim, R. Muslimen, K. Ab Hamid and P. Kuek. "Design, building and initial performance of an airboat for Sarawak rural riverine applications". First Regional Conference on

Vehicle Engineering and Technology. (Rivert 2006) Putra World Trade Centre (PWTC), Kuala Lumpur 03-05 July 2006.

2. Baini, R. (2003). Chemical reaction hazards – a need for safety awareness, *Proceedings National Occupational Safety and Health Conference,* 21 – 22 April, University Utara Malaysia, Penang, Malaysia, 53 - 60.

3. Baini R., & Saleh, S. F. (2003). Fault tree analysis in the modification of an engineering system, *Proceedings of Engineering & Technology Conference*, Sarawak, 30 July – 1 August, University Malaysia Sarawak, Malaysia, 688 -695.

4. N. Abdul Rahman, Prediction of Engine Performance Running on Biogas with hydrogen addition, Proceedings, Malaysian Science and Technology Congress 2002 (MSTC 2002) Symposium A – Physical Sciences, Engineering and Technology, Johor Bahru, 19 – 21 September 2002.

5. N. Abdul Rahman, Improving The Burning Characteristic of Biogas with the Addition of Hydrogen, Proceedings, Malaysian Science and Technology Congress 2002 (MSTC 2002) Symposium B – Environment, Biodiversity and Resource Management, Genting Highlands, 17-19 October 2002.

6. S.F. Salleh, N.H. Ibrahim, Potential energy from agricultural waste; effect of moisture content., National Conference On Advances In Mechanical Engineering, 18-20 May 2005, Universiti Teknologi Mara. (2005).

7. S.F. Salleh, Environmental Impact Assessment of A Chemical Plant; Potential Chronic Environmental Hazard of Chemicals To Aquatic and Terrestrial Ecosystem, Proc. Eng. & Tech. Conf. 2003 (EnTech 2003), 30 July – 1 Aug (2003).

V- Journals submitted & in review

1. M.O Abdullah, J. Zen and M. Yusof, 2006, Stress Corrosion Cracking of Industrial Ammonia Tank and an improved Crack Growth Model, Corrosion Engineering Science & Technology (submitted).

2. Mohammad Omar Abdullah, Kong Wen Keit andTan Teck Siong (2007). Effect of fuel catalyst on IC engine's power performance and emissions: an experimental study, Journal of Automobile Engineering (Submitted).

3. Baini, R. & Langrish, T.A.G. (2008). The assessment of variations in banana properties and their effects on drying behaviour, submitted to *Journal of Food and Bioprocess Technology* (submitted).

4. Baini, R. & Langrish, T.A.G. (2008). Assessment of colour development in dried bananas – measurements and implications for modeling, submitted to *Journal of Food Engineering* (submitted).

5. etc.

Lampiran D
Kemudahan Infrastruktur

Kemudahan Infrastruktur

JKKST telah mempunyai infrastruktur yang telah pun disediakan khas untuk tujuan pembelajaran, pengajaran serta penyelidikan seperti yang dipamerkan di Photo F1 - Photo F3.

Kemudahan-kemudahan sedia ada ialah Bangunan JKKST yang terdiri daripada:

- Bilik syarahan.
- Bilik makmal dan bilik komputer.

Photo F5 – Photo F8 menunjukkan bilik-bilik syarahan dan makmal-makmal yang sedia ada tetapi masih kosong.

Photo F1. Pandangan depan bangunan JKKST

Photo F2. Pandangan sisi bangunan JKKST

Photo F3. Pandangan tepi dari sebelah atas bangunan JKKST.

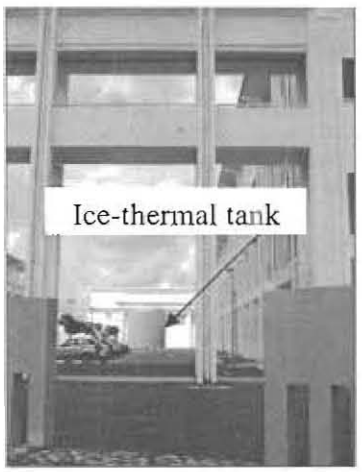

Photo F4. Pandangan dari bangunan JKKST. *Ice-thermal tank* jelas kelihatan di belakang.

Photo F5. Pandangan ruang legar *hanger* makmal di JKKST.

Photo F6. Ruang makmal yang masih kosong – View 1: Bilik komputer/ CAD.

Photo F7. Ruang salah satu makmal yang masih kosong – View 2: Makmal Tindakbalas Kimia.

Photo F8. Lagi ruang salah satu makmal yang masih kosong – View 3: Makmal Termofluid & Sustainabiliti Tenaga *(Thermofluid & Energy Sustainabilty* Lab).

Lampiran E
Borang Soal-Selidik *Stakeholder Survey*

STAKEHOLDER SURVEY

Organization Being Assessed: DEPARTMENT OF CHEMICAL ENGINEERING, FACULTY OF ENGINEERING, UNIMAS.

Stakeholder Organization: _____

Your role in Stakeholder Organization: _____

Location of Stakeholder Organization: _____

Tel no./Fax no/ email: _____

1. Which of the following best describes your organization as a whole?

[ ] Government Institution [ ] Semi-Government Institution [ ] Private Company [ ] Non-profit Organization

2. Tenure of Relationship:

[ ] < 1 year [ ] 1-3 years [ ] 4-6 years [ ] 7-10 years [ ] > 10 years

Please rate the elements below according to its **relevance** and **weight of importance** in your organization.

PART A1

	Engineering graduates should have the following attributes:	Not Very Crucial				Very Crucial
1.	Ability to apply theoretical and practical engineering skills in work.	1	2	3	4	5
2.	Ability to be flexible and resourceful in adjusting to new working environment.	1	2	3	4	5
3.	Having a high level of current technical expertise relevant to current work requirements.	1	2	3	4	5
4.	Ability to organize work and manage time effectively.	1	2	3	4	5
5.	Ability to set and justify priorities.	1	2	3	4	5
6.	Ability to retrieve and/or convey information effectively in both oral and written forms of communication.	1	2	3	4	5

PART A2

1.	How would you rate the quality of the intended program provided by the organization (UNIMAS Chemical Eng)	Very Poor [ ]	Poor [ ]	Uncertain [ ]	Good [ ]	Excellent [ ]
2.	How would you rate the effectiveness of the programs provided by the organization?	Very Poor [ ]	Poor [ ]	Uncertain [ ]	Good [ ]	Excellent [ ]
3.	How would you rate the impact this organization has on the community?	Very Poor [ ]	Poor [ ]	Uncertain [ ]	Good [ ]	Excellent [ ]
4.	How would you assess the organization's long term sustainability?	Very Poor [ ]	Poor [ ]	Uncertain [ ]	Good [ ]	Excellent [ ]
5.	How well does the organization take into consideration of industrial demands?	Very Poor [ ]	Poor [ ]	Uncertain [ ]	Good [ ]	Excellent [ ]
6.	Do you believe the organization has expansion/growth potential?	Very Unlikely [ ]	Not Likely [ ]	Uncertain [ ]	Likely [ ]	Very Likely [ ]
7.	Would you classify the organization as having an entrepreneurial culture?	Very Unlikely [ ]	Not Likely [ ]	Uncertain [ ]	Likely [ ]	Very Likely [ ]

PART A3

1. Overall, how do you think about the intended program with that of other institution in Malaysia?

[ ] does not meet expectation [ ] meets expectation [ ] exceeds expectation

[ ] not applicable

2. What do you think about the intended niche area here at the Chemical Eng. Dept. of UNIMAS? (niche area = energy and natural resources).

3. What do you think about our Program Education Outcome (PEO), and the mapping of PEO with that of the Faculty and University's vision and mission?

PART B

1. Please outline the key trends and changes that are facing your professional area/industry over the next three to five years and which UNIMAS should be addressing in order to keep its curriculum relevant and up-to-date:

2. What, in your opinion, will be the most important attributes, skills, abilities and knowledge needed by graduates in a professional area/industry like yours over the next three to five years?

2. What, in your opinion, will be the most important attributes, skills, abilities and knowledge needed by graduates in a professional area/industry like yours over the next three to five years?

Short Industrial Survey for BEng(Hons)Chemical Engineering Degree

Insitution and program being Assessed: Institution: Department of Chemical Engineering & Energy Sustaiability (ChemES), Faculty of Engineering, Universiti Malaysia Sarawak (UNIMAS), Kota Samarahan, Sarawak.
Proposed Program: **BEng(Hons)Chemical Engineering**

Name: _____

Your organization's name and address: _____

_____

Your current position: _____

Tel/Fax/email(optional): _____

Thick √ where appropriate:

Which of the following best describes your organization as a whole (optional)?

[ ] Government Institution [ ] Semi-Government Institution [ ] Private Company [ ] Non-profit Organization

		Very poor (very disagree) 1	2	3	4	5	6	7	8	9	Excellent (most agree) 10
1.	Would you agree that this program be offered at this time?										
2.	How would you rate the quality of the proposed program?										
3.	Would you think the proposed program fulfill the prior knowledge or skill required by industries?										
4.	Would you think there is demand for the program for years to come?										
5	What do you think about the niche area? (Niche area = energy sustainability).										

6. Other comments or suggestions (if any).

_____

_____

_____

_____

- - - Many thanks for your time and feed-back - - -

Mokhtar_Said@dynacraft.com
08/15/2007 04:59 PM

To amomar@feng.unimas.my
cc
bcc
Subject Industrial survey

History: This message has been forwarded.

Just received your letter dated. Thursday, 02 August 2007.
My view as below:

Name : Mokhtar bin Said
Organisation : Dynacraft Industries Sdn Bhd.
255-A, Block D, Phase 2,
Bayan Lepas Industrial Zone,
11900, Penang.
Describes : Private Company
Position : Training & Development Manager
Email : mokhtar_said@dynacraft.com

1. Agree that this program be offered at this time? 9
2. Rate the quality of the proposed program? 8
3. Proposed program fulfill the prior knowledge/skill required by Industries? 10
4. Demand for the program for years to come? 8
5. About the niche area? 7

6. In my organisation engineer with Chemical Engineering very much needed as the operation 40% dealing with chemical and 60% mechanical. Due to difficulties on getting the right candidate, some of the engineers, for Chemical Operation (plating & etching operation) been employed on others engineering subjects. They then been trained by In-House trainer. What we have in mind is this fresh engineer already have the Engineering Knowledge and Thinking and they just need to be filled up with the hands-on Chemical work and the actual working environment. It will always be good if we able to employ engineer with the Chemical Engineering (major subject) and it is a bonus if that engineer come with more then 3 years working experience.

Thanks & regards

Mokhtar bin Said
Training & Development,
Human Resource Department.
Dynacraft Industries Sdn Bhd
FIZ, Penang.
Email : mokhtar_said@dynacraft.com
Call ext : 506
Speed Dial . **593

Lampiran F

Kursus Generik

Kursus Pembangunan Generik (G) Bagi Kemasukan 2007/2008

Pelajar perlu mengambil **12 jam kredit** Modul Kursus Generik. Sebahagian daripada kursus ini dikendalikan oleh Fakulti manakala sebahagian lagi akan dikendalikan oleh Pusat Pengajian Bahasa.

Kursus yang dikendalikan oleh Fakulti masing-masing

Kod	Nama Kursus	Kredit	Catatan
TMX2012	Alatkuasa Untuk Pekerja Ilmuan	2	Pelajar perlu lulus Ujian Penempatan IT (UPIT) atau lulus kursus TMX1011 Komputan Pengguna
SSX0012	TITAS 1	2	
SSX0022	Hubungan Etnik	2	
SSX----	Asas Keusahawanan	2	
	JUMLAH	**8**	

Kursus yang dikendalikan oleh Pusat Pengajian Bahasa/ Center for Language Studies (PPB/CLS)

Kod	Kursus	Kredit	Catatan
PBI1012	English for Professional Purposes	2	Pelajar dikehendaki memilih **2 kursus** sahaja. Pelajar yang memperoleh MUET band 4-6 atau lulus kursus PBI0011 Preparatory English 1 dan PBI0021 Preparatory English 2 dikehendaki memilih **hanya 2** daripada kursus tersebut.
PBI1022	Creative Writing In English	2	
PBI1032	Academic Reading and Writing	2	
PBI1052	English for the Real World	2	
PBI1062	English for Self-Expression	2	
PBM2022	Bahasa Malaysia	2	Diwajibkan untuk semua pelajar
	JUMLAH	**6**	

KURSUS PENGUKUHAN (R)

Bagi pelajar yang tidak menduduki atau gagal Ujian Penempatan IT (UPIT) yang dikendalikan semasa Minggu Aluan Pelajar, maka mereka diwajibkan untuk menghadiri Kursus Pengukuhan (R)

Dikendalikan oleh Fakulti masing-masing

Kod	Kursus	Kredit
TMX1011	Komputan Pengguna	0

Pelajar yang mendapat MUET di dalam Band 1-3 diwajibkan menghadiri dua kursus bahasa inggeris persediaan di bawah ini.

Dikendalikan oleh Pusat Pengajian Bahasa/ Center for Language Studies (PPB/CLS)

Kod	Kursus	Kredit
PBI0011	Preparatory English 1	0
PBI0021	Preparatory English 2	0

Lampiran G

Pertindihan Kursus Dengan Institusi-institusi Lain

Lampiran G: PERTINDIHAN KURSUS DENGAN INSTITUSI-INSTITUSI LAIN

Jadual G1
Senarai IPTA yang menawarkan program Ijazah Sarjana Muda Kejuruteraan dengan Kepujian (Kejuruteraan Kimia) atau ijazah yang hampir serupa.

Universiti	Fakulti/Jabatan	Program Ijazah yang ditawarkan
Universiti Putra Malaysia (UPM), Selangor	Jabatan Kejuruteraan Kimia dan Alam Sekitar	• Ijazah Sarjana Muda dengan Kepujian Kejuruteraan (Kimia) • Ijazah Sarjana Muda dengan Kepujian Kejuruteraan (Proses dan Makanan)
Universiti Teknologi Malaysia (UTM), Johor	Fakulti Kejuruteraan Kimia dan Sumber Asli	• Ijazah Sarjana Muda dengan Kepujian Kejuruteraan (Kimia) • Ijazah Sarjana Muda dengan Kepujian Kejuruteraan (Bioproses) • Ijazah Sarjana Muda dengan Kepujian Kejuruteraan (Gas) • Ijazah Sarjana Muda dengan Kepujian Kejuruteraan (Polimer) • Ijazah Sarjana Muda dengan Kepujian Kejuruteraan (Petroleum)
Universiti Malaysia Pahang (UMP), Pahang	Fakulti Kejuruteraan Kimia dan Sumber Asli	• Ijazah Sarjana Muda dengan Kepujian Kejuruteraan (Kimia) • Ijazah Sarjana Muda dengan Kepujian Kejuruteraan Kimia (Bioteknologi) • Ijazah Sarjana Muda dengan Kepujian Kejuruteraan Kimia (Teknologi Gas)
Universiti Sains Malaysia (USM), Pulau Pinang.	Sekolah Kejuruteraan Kimia	Ijazah Sarjana Muda Kejuruteraan Kimia dengan Kepujian, dengan salah satu daripada pengkhususan berikut: • Kawalan Proses • Biokimia dan Kejuruteraan Alam Sekitar • Proses Pengasingan dan Pemangkin
Universiti Malaysia Sabah (UMS), Sabah	Sekolah Kejuruteraan dan Teknoloji Maklumat	Ijazah Sarjana Muda Kejuruteraan Kimia dengan Kepujian
Universiti Kebangsaan Malaysia (UKM)	Jabatan Kejuruteraan Kimia & Proses	Ijazah Sarjana Muda Kejuruteraan Kimia
Universiti Teknologi Mara (UiTM), Shah Alam	Fakulti Kejuruteraan Kimia	• Ijazah Sarjana Muda Kejuruteraan dengan Kepujian (Kimia) • Ijazah Sarjana Muda Kejuruteraan dengan Kepujian (Proses)
Universiti Malaya (UM),	Fakulti Kejuruteraan	• Ijazah Sarjana Muda Kejuruteraan Kimia • Ijazah Sarjana Muda Kejuruteraan BioPerubatan • Ijazah Sarjana Muda Kejuruteraan Alam Sekitar
Universiti Malaysia Perlis	• Sekolah Kejuruteraan Bioproses	• Ijazah Sarjana Muda Kejuruteraan (Kejuruteraan Bioproses)
	• Sekolah Kejuruteraan Alam Sekitar	• Ijazah Sarjana Muda dengan Kepujian (Kejuruteraan Alam Sekitar)

Jadual G2

IPTS yang menawarkan program Ijazah Sarjana Muda Kejuruteraan Kimia.

Universiti	Fakulti/Jabatan	Program Ijazah yang ditawarkan
The University of Notingham Malaysia Campus	School of chemical and environmental engineering	• BEng Chemical Engineering • BEng Chemical Engineering with Environment Engineering
Curtin University of Technology, Miri, Sarawak	School of Engineering and Science	BEng(Chemical Engineering)
Universiti Teknologi Petronas (UTP)	Engineering	Bachelor of Engineering (Hons) Chemical Engineering. Majors offered: - Industrial Environmental Engineering - Process Plant engineering - Gas and Petrochemical Engineering - Petroleum Engineering - Process analysis and Control.
Swinburn University of Technology, Sarawak	School of Engineering	Have not been offered.
Monash University Malaysia	School of Engineering	Bachelor of Engineering (Chemical)

Jadual G3

Institusi luar negara yang menawarkan program Ijazah Sarjana Muda Kejuruteraan Kimia.

Universiti	Fakulti/Jabatan	Program Ijazah yang ditawarkan
The University of Sheffield, UK.	Department of Chemical and Process Engineering	BEng Chemical Engineering
Loughborough University (LU), UK	Department of Chemical Engineering	• BEng(Hons) Chemical Engineering

		• BEng(Hons) Chemical Engineering with Environment Protection • BEng(Hons) Chemical Engineering with Management
Massachusetts Institute of Technology (MIT), USA	Department of Chemical Engineering	• Bachelor of Science (B.S.) in Chemical Engineering • Bachelor of Science (B.S.) in Chemical-Biological Engineering
Colorado School of Mines (CSM), USA	Department of Chemical Engineering	Bachelor of Science (B.S.) in Chemical Engineering
University of Rochester, USA	Department of Chemical Engineering	Bachelor of Science (B.S.) in Chemical Engineering
Monash University, Australia	Department of Chemical Engineering	Bachelor of Engineering (Chemical)
Tohoku University, School of Engineering, JAPAN	Department of Applied Chemistry, Chemical Engineering and Biomolecular Engineering	Bachelor of Engineering

Jadual G4
Pertindihan kursus dengan IPTA tempatan dan universiti luar negara

Komponen Kursus	**Pertindihan dengan Universiti Tempatan**									**Pertindihan dengan Universiti Luar Negara**			
	UNIMAS	UTM	UKM	UMP	UTP	UMS	USM	UM	UiTM	Monash University (Australia)	University of Rochester (US)	MIT (US)	CSM (US)
Mekanik Bendalir	*	*	O	*	*	*	O	*	*	*	*	*	*
Termodinamik	*	*	*	*	*	*	*	*	*	*	*	*	*
Proses Kimia	*	O	*	O	O	*	O	*	*	O	*	O	O
Kimia Organik	*	O	*	*	*	O	*	*	O	O	O	O	*
Keseimbangan bahan & haba	*	*	O	*	*	*	*	O	*	*	*	O	*
Lukisan Kejuruteraan	*	*	O	*	*	O	*	*	O	O	O	O	O
Ekonomi Kejuruteraan	*	*	*	*	*	O	O	*	O			O	*
Proses Pengasingan & Teknologi partikel	*	*	*	O	*	*	*	*	*	*	*	*	O
Proses Pemindahan	*	*	*	O	*	O	*	*	*	*	*	*	*
Sistem Kawalan Proses	*	*	O	*	*	*	*	*	*	*	*	*	*
Kimia Analisis	*	O	*	*	O	O	*	O	O	O	O	O	O
Pemprograman Kejuruteraan	*	*	*	*	*	*	*	*	*	*	*	*	*
Imbangan Tenaga	*	*	O	O	*	*	*	O	*	*		O	*
Kejuruteraan Alam	*	O		*	O	*	*	O	O	O	*	O	

Sekitar													
Proses Instrumentasi	*	O	O	*	*	O	O	O	*	O	O	O	O
Kejuruteraan Bahan	*	*	*	*	*	*	*		*	*	O		O
Proses Tindakbalas Kimia	*	*	*	*	*	*	*	*	*	*	*	*	*
Operasi Unit Kimia	*	O	*	*	*	O	O	O	O	O	O	O	*
Keselamatan Pekerjaan dan Kesihatan	*	O	O	*	*	*	O	O	O			O	
Rekabentuk Projek	*	*	*	*	*	*	*	*	*	*	*	*	*
Jaminan Kualiti dan Reliabiliti	*			O		O	O						
Sumber tenaga dan aplikasi	*	O	O								*	O	
Polimer untuk aplikasi tenaga	*										O	O	O
Kursus Elektive:													
Biodiesel dan Fuel Cell untuk Pengangkutan	*		O						O	O	*		O
Kejuruteraan Rawatan Air dan Air Sisa	*	O	O	O		O					*		
Kejuruteraan Gas Asli	*	*				O	O		O				*
Tenaga-Bio	*	O				O	O		O		O		O
Sustainabiliti dalam Industri Tenaga	*		O							O	O	*	

* Kursus melebihi 85% dengan nama atau kandungan kursus di UNIMAS

O 40-50% serupa dengan nama atau kandungan kursu

Lampiran H
Kandungan Silibus

KANDUNGAN
CONTENTS

B. KURSUS ELEKTIF / *ELECTIVE COURSES*

C. KURSUS TERAS FAKULTI KEJURUTERAAN / *ENGINEERING FACULTY CORE COURSES*

TAHUN 1

Course Code	**KNC 1013**
Course Title	**Fluid Mechanics**
Course Credit	3 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	Fundamental concept of fluid properties, dynamics and kinematics Viscosity, Newtonian and non-Newtonian fluid, Fluid Static, Fluid Dynamics, Dimensional analysis and similarity law, and two dimensional potential flow.
Course Aims	The aim of this course is to introduce fundamentals of fluid mechanic principles to the student and the associated applications in the chemical engineering field.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Define and describe the terminology used in fundamental fluid mechanics studies. • Differentiate the various types of fluid flow. • Underline the impacts of fluids properties to static and dynamics fluid flow. • Apply and interpret governing equations in fluid mechanics.
Learning Units	**LU 1: Fundamental concepts** – terminology, units of measurement, properties of fluids, differences between solids and fluids. **LU 2: Viscosity and flow between two plates** – Dynamics & kinematics viscosity, Newtonian and non-Newtonian fluid. Viscous forces, torque and power. Applications: viscometer, journal and thrust bearing.

LU 3: Fluid static

-Pascal Law, basic equation for fluid in static, measurement devices for fluid flow and pressure, barometer, manometer U-tube, inclined manometer, inverted manometer, micro-manometer.

-Hydrostatic pressure. Hydrostatic force on submerged bodies (flat and curve surfaces) such as water gates. Centre of pressure, mass, gravity and centroid.

-Buoyancy, Archimedes principle, buoyancy force, centre of buoyancy, metacentre, metacentric height, metacentric radius and stability.

LU 4: Fluid in motion

-Steady, unsteady, uniform and non-uniform flow. Introduction to laminar and turbulent flow, Reynolds number, flow profiles.

-Equation of motion – Euler, Bernoulli, energy and momentum equations. Darcy formula. Hydraulic and energy grade line. Application of the equation of motion.

-Fluid meters and volume-flow measurement i.e. pitot tube, pitot-static tube, orifice, venturi, rotameter and etc. Velocity, contraction and discharge coefficient.

-Pipeline problems. Losses in pipe, branched pipe. Introduction to fluid machines and pipe network. Moody diagram. Pumps and turbines.

-Application of energy and momentum equations: Force exerted on fluid jet striking flat and curved plate (static and moving plate). Application to fluid machines such as Pelton wheel turbine. Force exerted on pressure conduits.

LU 5: Dimensional analysis and similarity law – Direct (Rayleigh) method and Buckingham PI theorem. Application of similarity law between model and prototype.

LU 6: Two Dimensional Potential Flow – Stream Function, Potential Velocity, Circulation, Vorticity, Rotational and Irrotational Flow, Uniform Flow, Sink, Source, Pair, Doublet, Forced Vortex, Combination of flow, Flow past cylinder (rotating and stationary), Kutta-Joukowsky Theorem.

Teaching – Learning Approach

	Hours per semester
Lectures	28
Tutorials	28
Seminars	
Laboratory based practical	
Non-laboratory	

Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	40
	Assignment(s)	40
	Project(s)	
	Seminars/Presentations	
	Report(s)	
	Total	100
Resources	1. Munson, B.R., Young, D. F., Okiishi,T. H., [2005], *Fundamentals of Fluid Mechanics*,5th Edition, John Wiley & Sons Inc. 2. Wilkes, J. O., [2005], *Fluid Mechanics for Chemical Engineer*, 2nd Edition, Prentice Hall. 3. Cengel, Y. A., Cimbala, J.M, [2004] *Fluid Mechanics* 3rd Edition, Mac Graw-Hill. 4. Cohen, I. M., Hundu, P.K., [2004] *Fluid Mechanics,* 3rd Edition, Academic Press. 5. White, F.M., [2002] *Fluid Mechanics 5th Edition*. Mc Graw-Hill International Editions, Mechanical Engineering Series.	

Course Code	**KNC 1022**
Course Title	**Engineering Physical Chemistry**
Course Credit	2 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	The course covers physical properties of gases and basic concepts of thermodynamics. It also includes free energy, chemical equilibria and electrolytes in solution. The course also covers electromotive force if electrochemical cells and phase equilibria.
Course Aims	To introduce students with the fundamentals numerical and physical component of chemistry relevant to chemical industry.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Identify broad structure and logic of physical chemistry. • Describe physical chemistry proficiently. • Analyse different phenomena of physical chemistry. • Explain phases of equilibria.
Learning Units	**LU 1: Physical Properties of Gases** – Boyle's Law, PV=nRT, Gas Mixture, Real Gas PVT, Critical Point. **LU 2: Kinetic Molecular Theory of Gases** – Kinetic – Molecular Theory, Molecular Energies and Speeds, Van der Waals' Equations, Molecular interactions. **LU 3: Energies in Atomics-Molecular** – Molecular Energies, Vibration Energies, Rotational Energies. **LU 4: Energies of Collections of Molecules** – Thermal Energy,

	Boltzman Distribution, one dimensional and three dimensional translation motions, Gas Heat Capacities, Crystals and liquid heat capacities. **LU 5: Energy and the 1st Law of Thermodynamics** – Energy, Enthalpy and Chemical Reactions, Heat Capacities, adiabatic Expansions and Compressions, Bond Energy, Crystals Energies, Aqueous Ion Energies. **LU 6: Entropy and the 2nd and 3rd Law of Thermodynamics** – 2nd law of Thermodynamics, Entropy, Entropies at Absolute Zero, 3rd law of Thermodynamics, Molecular Basis of Entropy. **LU 7: Free Energy and Chemical Equilibria** – Free Energy, Equilibria and distributions, Fugacity, Free energy of real gases. **LU 8: Thermodynamics Treatment of Solutions** – Ideal Mixtures, Partial Molal Quantities, Liquid-Vapour Free Energies, Raoult's law, Henry's Law, equilibrium constant for solutes. **LU 9: Electrolytes in Solution** – Specific Conductance, Molar conductance, Electrolysis, Ionics Mobilities, dielectric Effect, Ionic Strength. **LU 10: Electromotive Force of Electrochemical Cells** – Electrodes, Cell EMF, Standard Electrode potentials, Junctions Potentials, Salt Bridge. **LU 11: Phase Equilibria** – Pressure-Temperature Phase Diagrams, Clausius Clapeyron Equations, Liquid Surfaces, Surface Tension and Vapour Pressure, Phase Equilibria, Phase rule, Immiscible Liquids, Eutectic Formations, Solid – compound Formation, Three – Component, Solid Liquid system, Liquid Vapour, Boiling points diagrams.

Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	
	Seminars	
	Laboratory based practical	
	Non-laboratory	

Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	40
	Assignment(s)	40
	Project(s)	
	Seminars/Presentations	
	Reports	
	Total	100
Resources	1. Atkins, P.W., [2006], *Physical Chemistry*, 8th Editions, Oxford University Press, Oxford. 2. Robert J.Sibley., [2004], *Physical Chemistry*, Willey. 3. Levine, I. N., [2003], *Physical Chemistry*, 7th Edition, McGraw Hill, New York. 4. D.W., Ball., [2002], *Physical Chemistry*, 1st Edition, Brooks Cole.	

Course Code	**KNC 1032**
Course Title	**Engineering Drawing**
Course Credit	2 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	An introductory course in engineering graphics covering the application of the principles of geometric drawing and perspective to the preparing of engineering drawings. Topics include conventions and standards in engineering drawing, free hand sketching, dimensioning and tolerance, use of standards and conventional presentation of machine elements, assembly drawing, and introduction to computer aided drafting.
Course Aims	To introduce students with the technical part and the basic needs for technical drawing.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Apply the principles, terms and techniques in engineering drawing to produce a technical drawing • Communicate design ideas into a technical drawing • Use CAD software as a tool to produce a technical drawing • Identify and communicate with other engineers on any engineering drawing. • Interpret AutoCAD/other CAD for drafting and drawing 2-D and 3-D drawing.

Learning Units	**LU 1: Instruments for Drawing** - Equipment used in drawing. **LU 2: Lettering and Dimensioning** - Lettering styles and constructions, Techniques, symbols and size in dimensioning. **LU 3: Sketching and Shaping** - Techniques for sketching, Sketching the objects views. **LU 4: Geometric Construction** - Definitions of terms, Geometric constructions. **LU 5: Multiviews Projection** - Projection method, Visualizing views. **LU 6: Sectional Views** – Sectioning, Visualizing a section. **LU 7: Tolerancing** – Terms, Symbols. **LU 8: Auxiliary Views and Revolutions** - Techniques to draw auxiliary views, Techniques of revolution. **LU 9: Threads and Fasteners** – Techniques, Symbols. **LU 10: Computer aided drafting** - Creating simple sketches features, Modelling fundamentals, 2 dimensional drawing, 3 dimensional drawing, dimensioning, parts assembly, presentation and animation or analysis.

Teaching - Learning Approach		**Hours per semester**
	Lectures	14
	Tutorials	
	Seminars	
	Laboratory based practical	14
	Non-laboratory	

Assessment		**Percentage**
	Test(s)/Quizzes	
	Final Test	
	Assignment(s)	60
	Project(s)	40
	Seminars/Presentations	
	Report(s)	
	Total	100

Resources	1. Boundy, A. W, [2006], *Engineering Drawing,* McGraw-Hill 2. Shah, M. B. [2005], *Engineering Drawing*, Pearson Education (Singapore) Pte Ltd 3. Bertoline, G. R. [2005], Introduction to Graphics Communications For Engineers, McGraw-Hill 4. Autodesk Official Training Courseware (AOTC) [2005], *Autodesk Inventor 10*, Autodesk Inc. 5. Giesecke F. E., Mitchell, A., Spencer, H. C., Hill, I. L., Dygdon, J. T., Novak, J. E., and Lockhart, S. [1997], *Technical Drawing (10th edition)*, Prentice Hall 6. HillLuzadder, W. J. and Duff, J. M., [1993], *Introduction to Engineering Drawing: The Foundations of Engineering Design and Computer-Aided Drafting*, Prentice Hall

Course Code	**KNC 1042**
Course Title	**Introduction to Materials and Heat Balance**
Course Credit	2 hrs
Type of Course	Core / Complimentary
Requisites	None
Instructor	
Courses Synopsis	Flow sheet, Continuous processes, The material balance, Energy and States of Matter, Specific properties, Enthalpy of phase changes, The energy balance for reactive system, example of chemical industries
Course Aims	The aim of this course is to provide the fundamental intellectual tools especially on mathematical methodologies for analysis and design of chemical processes with respect to the flows of material and energy. In addition, this course will also demonstrate that in a manufacturing chemical process, matter is transformed or chemically changed under a scheme or flow sheet which is economically workable under safe plant processes.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Define a chemical process using a flow sheet. • Differentiate steady and non-steady continuous processes. • Explain and discuss a material and energy balance. • Apply the tools to a variety of types of processes. • Produce and evaluate complete mass and energy budgets and estimation of process efficiency.
Learning Units	**LU 1: Flow sheets** -The description and interpretation of chemical processes using line diagrams and flow sheets.

	LU 2: Continuous Processes -Steady and non-steady operation of continuous processes. Application of the principle of conservation of mass and energy in the analysis of processes. **LU 3: The Material Balance** -Examples taken from contemporary industries are used to illustrate a general approach to process analysis of systems of increasing complexity. Systems involving physical mixing or blending (steady and non-steady operation). Systems with highly complex reaction. Systems producing by-products (parallel reactions). Systems with bypass and/or recycle and purge facilities. **LU 4: Energy and States of Matter** -Forms of energy (energy possessed and energy in transit), 1st law of thermodynamics, concepts of energy, heat and work; distinction between a system and its surroundings; physical properties as functions of state. Conservation of energy applied to non-flow and steady-state flow processes. **LU 5: Specific Properties** -Enthalpy determination and calculation. Tables of data: Reference states and state properties. Use of tabulated data, use of steam tables, evaluation of unknown enthalpies by process paths (from initial to final conditions via intermediates). Sensible heat and heat capacities: Polynomial and mean forms. **LU 6: Enthalpy of Phase Changes** -Balances over systems involving phase changes. Estimates of energy associated with phase change. **LU 7: The Energy Balance for Reactive Systems** -Calculations using heat of reaction/combustion for isothermal and adiabatic systems. Hess's law. **LU 8: Chemical Industries** -Introduction to a typical industries e.g. chemicals, petroleum products, plastics, pharmaceuticals, textiles, pulp and paper, glass, rubber, and food processing. Plant visit to one of the industry.

Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	
	Seminars	
	Laboratory based practical	
	Non-laboratory	

Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	40
	Assignment(s)	40
	Project(s)	
	Seminars/Presentations	
	Report(s)	
	Total	100
Resources	1. Solen, K. A., and J. N. Harb, [2005], *Introduction to Chemical Process Fundamentals & Design*, 5th Edition, McGraw-Hill, New York. 2. Branan, C. R., [2005], *Rules of Thumb for Chemical Engineers*, 4th Edition, Gulf Professional Publishing 3. Felder, R. M. & Rousseau R. W., [2004] *Elementary Principles of Chemical Processes* 3rd Edition, Wiley & sons. 4. Himmelblau, D.M., [2003], *Basic Principles and Calculation in Chemical Engineering*, 7th Edition, Prentice Hall.	

Course Code	**KNC 1052**
Course Title	**Engineering Organic Chemistry**
Course Credit	2 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	The course introduces different types of chemical bonding and different types of organic compounds. It covers the structure and empirical formula of different organic compounds.
Course Aims	To introduce students with the fundamentals of organic chemistry relevant to chemical industry.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Explain different types of chemical bonding. • Define and differentiate different structure of organic compounds. • Recognize various types of organic compounds. • Define functional group. • Apply empirical formula to a number of different isomers.
Learning Units	**LU 1: Chemical Bonding** – Ionic Bonding, Covalent Bonding, Polar Covalent Bonding, Isomers and Isomerism, Resonance, Empirical and Molecular Formulas.

	LU 2: Alkanes and Cycloalkanes – Methane, Orbital Hybridization and Bonding in Methane, Ethane and Propane, Conformations of Ethane and Propane, Isomeric Alkanes, Butanes, Higher Alkanes, IUPAC nomenclature, Cycloalkanes Nomenclature, Physical and Chemical Properties of Alkanes. **LU 3: Organic Chemical Reactions** – Hydrocarbon, Alcohols and Alkyl Halides, Acid-Base Properties of Organic Molecules, Structure and Stability of Carbocations, Electrophiles and Nucleophiles, Chlorination of Methane, Free Radicals. **LU 4: Alkenes, Alkadienes and Alkynes Structure and Preparations** **LU 5: Alkenes, Alkadienes and Alkynes Reactions** **LU 6: Arenes and Aromaticity** – Aromatics Compounds, Benzene, Polycyclic Aromatic Hydrocarbons, Electrophilics Aromatics **LU 7: Stereochemistry** – Molecular Chirality, Chirals Centers, Symmetry in Achiral Structures, Properties of Chiral Molecules **LU 8: Nucleophilic Substitution Reactions** – Reaction Mechanism, Stereochemistry of S_N2 Reactions, Steric Effects in S_N2 Reactions, Stereochemistry of S_N1 reactions **LU 9: Spectroscopy** – Electromagnetic Radiation, Infrared Spectroscopy, UV Spectroscopy, Nuclear Magnetic Resonance Spectroscopy, Interpreting Proton (^1H) NMR Spectra, Carbon-13 Nuclear Magnetic Resonance, Mass Spectrometry. **LU 10: Alcohols, Esters and Phenols**

Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	
	Seminars	
	Laboratory based practical	
	Non-laboratory	

Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	40
	Assignment(s)	40
	Project(s)	
	Seminars/Presentations	
	Report(s)	
	Total	100
Resources	1. Bettelheim, F.A., [2005], *Introduction to Organic and Biochemistry*, 6th Edition, Sauders College Publishing, Orlando, Florida. 2. Nechratal, A. & Tedder, J.M., [2004], *Basic Organic Chemistry, A Mechanistic Approach,* 7th Edition, John Wiley & Sons, Chichester, England. 3. Loudon, G.M., [2002], *Organic Chemistry,* McGraw Hill, New York. 4. Morrison R.T & Boyd R.N., [2002], *Organic Chemistry,* 8th Edition, Prentice Hall International, New Jersey	

Course Code	**KNC 1063**
Course Title	**Thermodynamics I**
Course Credit	3 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis:	Introduction to Basic Concepts of Thermodynamics, Properties of Pure Substances, Work and Heat, First Law of Thermodynamics: Closed Systems and Control Volume, Second Law of Thermodynamics, Entropy, Second-Law Analysis of Engineering Systems, Gas Power Cycles, Vapor and Combined Power Cycles, Refrigeration Cycles.
Course Aims	The aim of this course is to provide the student with basic knowledge of thermodynamics especially thermodynamics laws and application.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Define the basic concepts of thermodynamics. • Underline the properties of pure substances. • Explain principles of first and second law of thermodynamics. • Utilise the first and second law of thermodynamic in numerical calculation. • Explain and employ the basic principle of gas power cycle.
Learning Units	**LU 1: Introduction to Basic Concepts of Thermodynamics** -Thermodynamics and Energy, Closed and Open Systems, Forms of Energy, Properties of a System, State and Equilibrium, Process and Cycles, The State Postulate, Pressure, Temperature and Zeroth Law of Thermodynamics.

LU 2: Properties of Pure Substances

-Pure Substance, Phase of a Pure Substances, Phase Change Process of Pure Substances, Property Diagrams for Phase Change Process, Property Tables, The Ideal-Gas Equation of State.

LU 3: First Law Thermodynamics: *Closed Systems and Control Volumes*

-Introduction to the First Law of Thermodynamics, Heat transfer, Work, Mechanical Forms of Work, A Systematic Approach to Problem Solving, Internal Energy, Enthalpy and specific Heats of Solids and Liquids, Thermodynamic Analysis of Control Volumes, The steady-Flow Process, Steady-Flow Engineering Devices, Unsteady-Flow Processes.

LU 4: The Second Law of Thermodynamics

-Introduction to the Second Law of Thermodynamics, Thermal Energy Reservoirs, Heat Engines, Refrigerators and Heat Pumps, Perpetual-Motion Machines, Reversible and Irreversible Processes, The Carnot Cycle Principles and Heat Engine, The Carnot Refrigerator and Heat Pump.

LU 5: Entropy

-The Clausius Inequality, Entropy and the Encrease of Entropy Principle, Cause of Entropy Change, Property Diagrams Involving Entropy, The Tds Relations, Entropy Change of Pure Substances, Solids and Liquids and Ideal Gas, The Reversible Steady-Flow Work, Minimising the Compressor Work, Adiabatic Efficiencies of Some Steady Flow Devices.

LU 6: Second-Law Analysis of Engineering Systems

-Availability-Maximum Work Potential, reversible Work and Irreversibility, The Second-Law Efficiency, Second-Law Analysis of Closed Systems, Second Law Analysis of Steady-Flow Systems and Unsteady-Flow Systems.

LU 7: Introduction to Gas Power Cycles

-Basic Considerations in the Analysis of Power Cycles. The Carnot Cycle and Its Value in Engineering, Air Standard Assumptions, Brief Overview of Reciprocating Engines, Otto Cycle, Diesel Cycle, Stirling and Ericsson Cycles, Brayton Cycle, Ideal Jet-Propulsion Cycles, Second Law Analysis of Gas Power Cycle.

LU 8: Introduction to Vapor and Combined Power Cycles

-Carnot Vapor Cycle, Rankine Cycle, Ideal Reheat Rankine

	Cycle, Ideal Regenerative Rankine Cycle, Second-Law Analysis of Vapor Power Cycle.	
Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	28
	Seminars	
	Laboratory based practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	40
	Assignment(s)	40
	Project(s)	
	Report(s)	
	Total	100
Resources	1. Moran, M. J., Shapiro, H. N., [2007], *Fundamentals of Engineering Thermodynamics*, 6th Edition, Willey. 2. Cengel, Y.A. & Boles, M.A., [2005] *Thermodynamics: An Engineering Approach*, 5th Edition, McGraw-Hill, Inc. 3. Smith, J. M., Van Ness, H. C., & Abbott, M., [2004] Introduction to Chemical Engineering Thermodynamics, McGraw-Hill.	

Course Code	**KNC 1072**
Course Title	**Engineering Economy**
Course Credit	2 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	Cost Concepts and the Economic Environment, Money – Time relationships, Types of Interest, Cash Flow, Present, Future and Annual worth methods, Benefits/cost ratio method, depreciation, Inflation, Capital Financing and allocation.
Course Aims	The aim of this course is to provide the student understanding of the systematic evaluation of particular benefits and costs of projects involving design and analysis.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Underline the principals of money - time relationships. • Identify economic tools for project assessment. • Recognise some terms used in finance sectors. • Correlate the importance of economic factor to engineering design/project. • Evaluate project profitability by utilising the knowledge obtained for this course.
Learning Units	**LU 1: Introduction** – Cost concept, Money –time relationships **LU 2: Cost Concept and Economic Environment** – Cost terminology, Cost driven design optimization, present economy studies.

	LU 3: Principles of Money – Time Relationships – Simple Interest, Compound Interest, Cash flow diagram, Present, annual and future equivalents. **LU 4: Applications of Money** – Present worth method, Future worth method, Annual worth method, Internal rate of return, external rate of return, payback period method, investment balance diagram. **LU 5: Comparing Alternatives** – Study (Analysis) Period, Capitalized worth method. **LU 6: Benefit/Cost Ratio Method** – Self-liquidating projects, Multiple-purpose projects, Benefit/cost ratio method **LU 7: Depreciation and Income taxes** – Depreciation concept and terminology, depreciation (classical) methods, Modified accelerated cost recovery system, Depletion, Income taxes. **LU 8: Estimating Cash Flows** – Integrated approach, Estimating techniques, Estimating total product costs and selling prices. **LU 9: Inflation and Price Changes** – Terminology and Concept of inflation, Differential price inflation or deflation, Application strategy, Foreign exchange rate and purchasing power. **LU 10: Capital Financing and Allocation** – Capital financing, Debt capital, Equity capital, Leasing, Capital allocation.

Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	
	Seminars	
	Laboratory based practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	40
	Assignment(s)	20
	Project(s) / Case Study	20
	Seminars/Presentations	
	Report(s)	
	Total	100

Resources	1. Sulvian, W. G., Wicks, E. M., Lukhoj, J. ,[2006] *Engineering Economy* , 13th Edition, McGraw Hill 2. Blank, L. T., Tarquin, A., [2004], *Engineering Economy,* 6th Edition, McGraw Hill. 3. Newnan, D. G., Eschenbach, T. G., [2004] *Engineering Economic Analysis,* 9th Edition, Oxford University Press. 4. Newnan, D. G., Lavelle, J. P. & Eschenbach, T.G., [2002] *Engineering Economic Analysis.* 8th Edition, Engineering Press, Austin, Texas

Course Code	**KNC 1082**
Course Title	**Engineering Materials**
Course Credit	2 hrs
Type of Course	Core / Complimentary
Requisites	None
Instructor	
Course Synopsis	Classification of Material, Material Atomic and Crystal Structure, Phase Equilibrium Diagram, Mechanical Properties, Engineering Applications of Materials, Heat Treatment of Metals, Fick's laws of diffusion, Corrosion and Oxidation, Defect Evaluation and Failure Analysis.
Courses Aim	The course is providing the student with basic and relevant theory and application of materials properties.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Recognize the classification of materials. • Explain and discuss the molecular structure and phase transformation of material. • Relate the phase diagram to the solidification of metals and alloys. • Interpret the mechanical properties of material and its application. • Discuss and appraise heat treatment of metals. • Employs Fick's first and second law of diffusion. • Choose and employ suitable method(s) for defect evaluation.
Learning Units	**LU 1: Introduction and Classification of Materials** - metals and non metals, ferrous and non ferrous metals, glass, ceramic, plastic and composite materials.

	LU 2: Atomic and Crystal Structure of Materials - basic atomic structure, basic cubic, body centered cubic and face centered cubic structure, crystal plan and directions, Millers Index, co-ordination number, atomic packing factor. **LU 3: Phase Equilibrium Diagram** - concept and applications of phase equilibrium diagrams. Phase Transformation Microstructure Development - solidification of metals, solidification process, determination of composition and amount of phases using level rules and phase diagram. **LU 4: Mechanical properties of engineering materials and their determination** - basic mechanical properties, yield and ultimate tensile strength, elongation and ductility, hardness, fatigue and creep. **LU 5: Engineering applications of materials** - Ceramics, glass, metals, alloys, composite, polymer. **LU 6: Heat Treatment of Metals** - basic heat treatment process for ferrous and non-ferrous materials. Normalizing, annealing and hardening. Solution treatment and artificial ageing. Effects of heat treatment on mechanical properties. Time-Temperature-Transformation curves and applications. **LU 7: Diffusion** - Basic principles, Fick's first and second law of diffusion, diffusion control, application of diffusion. **LU 8: Corrosion and Oxidation** – Introduction to corrosion, electrochemical chemical potential series, corrosion processes, corrosion protection and control. **LU 9: Defect evaluation (Non Destructive Testing)** - Ideal 'defect-free' materials versus engineering materials, defects and their effects on the mechanical properties. Non-destructive evaluation of materials, X-ray radiography, Ultrasonic, Eddy current and Magnetic Particle Inspection.

Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	
	Seminars	

	Laboratory based practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	40
	Assignment(s)	40
	Project(s)	
	Seminars/Presentations	
	Report(s)	
	Total	100
Resources	1. Callister, W.D.Jr., [2007], *Material Science and Engineering: An Introduction,* 7th edition, John Willey and sons. 2. Askeland, D.P., [2005], *The Science and Engineering of Materials,* 5th edition, Thompson Engineering. 3. Callister, W.D.Jr., [2004], *Fundamental of Material science and Engineering: An Integrated Approach,* John Willey and sons. 4. Hankel, D.P., [2002], Structure and Properties of Engineering Materials, McGraw Hill.	

Course Code	**KNC 1091**
Course Title	**Workshop Practice**
Course Credit	1 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	This course includes the basic techniques of bench work and grinding processes, milling processes, welding processes, conventional lathe machine operation and simple electronics/electrical measurements.
Course Aims	The goal of this course is to expose students to the basic mechanical and manufacturing workshop practice environment and to enable students to apply their theoretical knowledge into construction of simple practical products.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Identify and apply safety procedures at workshop. • Identify and describe various basic workshop techniques such as bench work, welding and simple machine operations. • Utilise or operate tools and machines in the workshop with the correct techniques. • Identify some electronic components such as thermocouple and sensors. • Measure simple basic electronics parameters using a multi-meter. • Construct at least a simple chemical- or energy-related item/prototype/electronic circuit in the 14 weeks course. • Communicate clearly the results of their work in formal written reports.

<table>
<tr><td>Learning Units</td><td colspan="2">The student will undergone laboratory practice on the suggested topics below:

LU 1: Bench Work and Grinding
LU 2: Milling Operation
LU 3: Welding Process
LU 4: Lathe Machine
LU 5: Electronics Basic</td></tr>
<tr><td rowspan="5">Teaching - Learning Approach</td><td></td><td>Hours per semester</td></tr>
<tr><td>Lectures</td><td></td></tr>
<tr><td>Tutorials</td><td></td></tr>
<tr><td>Seminars</td><td></td></tr>
<tr><td>Laboratory based practical</td><td>28</td></tr>
<tr><td>Non-laboratory</td><td></td></tr>
<tr><td rowspan="7">Assessment</td><td></td><td>Percentage</td></tr>
<tr><td>Test(s)/Quizzes</td><td></td></tr>
<tr><td>Final Test</td><td></td></tr>
<tr><td>Assignment(s)</td><td>20</td></tr>
<tr><td>Project(s)</td><td>60</td></tr>
<tr><td>Seminars/Presentations</td><td></td></tr>
<tr><td>Report(s)</td><td>20</td></tr>
<tr><td>Total</td><td>100</td></tr>
<tr><td>Resources</td><td colspan="2">1. Degarmo, E. P., Black, J. T., & Kohser, R. A., [2004] Materials and Processes in Manufacturing, 10th Edition, John Wiley & Sons Inc.

2. Floyd T.L, [2004] Electronic Fundamentals. Pearson Prentice Hall. Sixth Edition.

3. Kalpakjian, S., & Schmid, S. R., [2003], Manufacturing Engineering & Technology (5th Ed.), Prentice Hall, Inc.

4. Bray, S., [2000], Useful Workshop Tools (Workshop Practice Series 31), Nexus Special Interest Ltd; 1 edition

5. Cain, T., [1998], Simple Workshop Devices (Workshop Practice Series), Nexus Special Interests.</td></tr>
</table>

Course Code	**KNC 1101**
Course Title	**Chemical Engineering Laboratory 1** **(Themofluid and Energy Sustainability)**
Course Credit	1 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	The subject introduces the basic principles of thermofluid. It covers characteristics of flow measuring devices (pipe loses, valves, pump), Otto and Diesel cycles and refrigeration/air-conditioning systems.
Course Aims	The aim of this course is to develop students' experimental techniques skills especially on topics related to thermodynamics and fluid mechanics, with emphasis on energy applications. This course will supplement the concepts and principles introduce in the lectures of thermodynamic and fluid mechanics courses.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Demonstrate laboratory skills in developing experimental techniques involving both theories in thermodynamics and fluid mechanics. • Explain the basic principle in fluid statics and dynamics. • Correlate thermofluid theories with the laboratory experiments. • Demonstrate team work through group-based laboratory work. • Express their findings from the experiments conducted in the form of report writing.

Learning Units	The student will undergone laboratory practice on the suggested topics below: **LU 1:** Fluid static **LU 2:** Fluid dynamics (fluid in motion) **LU 3:** Fluid meters and volume-flow measurement **LU 4:** Pump characteristics **LU 5:** Otto and diesel cycles **LU 6:** Refrigeration or air conditioning systems	
Teaching - Learning Approach		**Hours per semester**
	Lectures	
	Tutorials	
	Seminars	
	Laboratory based practical	28
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	
	Final Test	
	Assignment(s)	
	Project(s)	
	Seminars/Presentations	
	Report(s)	100
	Total	100

Resources	1. Moran, M. J., Shapiro, H. N., [2007], *Fundamentals of Engineering Thermodynamics,* 6th Edition, Willey. 2. Munson, B.R., Young, D. F., Okiishi,T. H., [2005], *Fundamentals of Fluid Mechanics*,5th Edition, John Wiley & Sons Inc. 3. Wilkes, J. O., [2005], *Fluid Mechanics for Chemical Engineer*, 2nd Edition, Prentice Hall. 4. Cengel, Y.A. & Boles, M.A.,[2005] *Thermodynamics: An Engineering Approach*, 5th Edition, McGraw-Hill, Inc. 5. Cengel, Y. A., Cimbala, J.M, [2004] *Fluid Mechanics* 3rd Edition, Mac Graw-Hill. 6. Smith, J. M., Van Ness, H. C., & Abbott, M., [2004] Introduction to Chemical Engineering Thermodynamics, McGraw-Hill 7. Cohen, I. M., Hundu, P.K., [2004] *Fluid Mechanics,* 3rd Edition, Academic Press. 8. White, F.M., [2002] *Fluid Mechanics 5th Edition.* Mc Graw-Hill International Editions, Mechanical Engineering Series.

TAHUN 2

Course Code	**KNC 2112**
Course Title	**Analytical Chemistry**
Course Credit	2 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	The course provides fundamental knowledge on electroanalytical methods and supports students to solve problems of complex chemical equilibria. The course also covers chromatography methods and instrumental methods. Finally, it introduces students on how to evaluate experimental data based on statistical measurement.
Course Aims	Aim of the course is to introduce to the students the fundamentals analytical chemistry and problem solving techniques involving complex chemical equilibria. The course uses example applications in chemistry, environmental science and engineering. The course covers acid/base, chelation, oxidation-reduction, and precipitation equilibria and absorption spectroscopy, gas chromatography, liquid chromatography, and instrumental methods.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Identify the concepts of Analytical Chemistry and its applications in chemical industry. • Apply the analytical chemistry knowledge in solving problems.
Learning Units	**LU 1: Electroanalytical Methods** – Methods with electron

<table>
<tr><td></td><td colspan="2">transfer and no current: direct potentionmetric measurements and potentiometric titration, Methods with mass transfer: voltammetry.

LU 2: Chromatography Methods – General principles and classification, Gas chromatography (GC), High performances liquid chromatography (HPLC).

LU 3: Instrumental Methods - Principles of Instrumental Analysis, Instrumental Methods of Measurements.

LU 4: Evaluation of Experimental Data – Central tendency, Dispersion, propagation of errors, Significance testing, Regression analysis.</td></tr>
<tr><td rowspan="6">Teaching - Learning Approach</td><td></td><td>Hours per semester</td></tr>
<tr><td>Lectures</td><td>28</td></tr>
<tr><td>Tutorials</td><td>28</td></tr>
<tr><td>Seminars</td><td></td></tr>
<tr><td>Laboratory based practical</td><td></td></tr>
<tr><td>Non-laboratory</td><td></td></tr>
<tr><td rowspan="8">Assessment</td><td></td><td>Percentage</td></tr>
<tr><td>Test(s)/Quizzes</td><td>20</td></tr>
<tr><td>Final Test</td><td>35</td></tr>
<tr><td>Assignment(s)</td><td>35</td></tr>
<tr><td>Project(s) / Case Study</td><td>10</td></tr>
<tr><td>Seminars/Presentations</td><td></td></tr>
<tr><td>Report(s)</td><td></td></tr>
<tr><td>Total</td><td>100</td></tr>
<tr><td>Resources</td><td colspan="2">1. Skoog, D.A., [2004], Fundamentals of Analytical Chemistry, 8th edition, Prentice Hall.

2. Christian, G.D., [2003] Analytical Chemistry, Willey and Sons.

3. Harvey, D., [2002] Modern Analytical Chemistry, MacGraw-Hill.

4. Bard, A.J., Faulkner, L.R., [2000] Electrochemical Methods: Fundamental and Application, Willey.</td></tr>
</table>

Course Code	**KNC 2122**
Course Title	**Introduction to Heat and Mass Transfer**
Course Credit	2 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	One-dimensional and steady state conduction, two dimensional and steady state conduction, transient conduction, fundamentals of convection, external flow and internal flow, free convection, boiling and condensation, heat exchangers, radiation heat transfer and diffusion mass transfer.
Course Aims	The aim of this course is to correlate the student understanding of thermodynamics and heat transfers principles to a more complicated and intriguing heat and mass related problems.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Define and discuss the principles of conduction, convection and radiation heat transfer. • Correlate the principles of heat transfers to actual processes. • Examine heat transfer problems. • Appraise the multi combination mode of heat transfer • Interpret and analyze problem involving both heat and mass transfer.

Learning Units	**LU 1: Conduction** – rate equations, thermal properties, heat diffusion equation, boundary and initial conditions. **LU 2: One Dimensional Steady State Conduction** – Plane wall, Radial system, Extended surfaces. **LU 3: Two Dimensional Steady State Conduction** – graphical method, Finite difference Equations, Finite difference Solutions. **LU 4: Transient Conduction** – Lumped Capacitance Method, Spatial Effects, Plane Wall System, Radial System. **LU 5: Convection** – Boundary layers, Laminar and turbulent flow, Convection transfer equations. **LU 6: External Flow** - Flat plate in parallel flow, cylinder in cross flow, sphere, impinging jets, packed beds. **LU 7: Internal Flow** – Hydrodynamics considerations, thermal considerations, energy balance, convection mass transfer. **LU 8: Free convection** – Physical Considerations, The governing equations, similarity Consideration, Laminar Free convection, Turbulent Effect. **LU 9: Boiling and Condensation** – Dimensionless parameter, Boiling Modes, Pool Boiling, Forced Convection Boiling, Condensation Physical Mechanism. **LU 10: Heat Exchanger** – Types, Overall heat transfer coefficient, Log Mean Temperature difference analysis, The effectiveness – NTU Method. **LU 11: Radiation** – Intensity, Blackbody, Surface Emission, Surface absorption, reflection and transmission, Kirchoff's law, Gray Surface, View Factor, Blackbody Radiation Exchange, Multi mode Heat Transfer. **LU 12: Diffusion Mass Transfer** – Physical Origin and Rate Equations, Conservation of Species, Boundary and initial conditions, Mass diffusion with and without homogeneous chemical reactions

Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	
	Seminars	
	Laboratory based practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	35
	Assignment(s)	35
	Project(s) Case Study	10
	Seminars/Presentations	
	Report(s)	
	Total	100

Resources

1. Incropera, F.P. & De Witt, D.P., [2006], *Fundamentals of Heat and Mass Transfer, 5th Editions*, John Wiley & Sons, New York.

2. Welty J.R., Wicks, C.E. and Wilson, R.E., [2004], *Fundamentals of Momentum, Heat and Mass Transfer, 6th Edition*, John Wiley & Sons, New York.

3. Mills, A.F., [2002], *Basic Heat and Mass Transfer, 2nd Edition*, Prentice Hall, New Jersey.

4. Benitz, J., [2002], *Principles and Modern Applications*, Willey Interscience.

Course Code	**KNC 2133**
Course Title	**Thermodynamics II**
Course Credit	3 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	Vapour Power Plants. Regenerative power plants. Gas Power Plants. Regenerative gas turbines. Refrigeration and air-conditioning system. Gas mixtures and psychrometic applications. Combustion. Reacting mixtures. Fuel cell.
Course Aims	The aims of this course is to correlate the student understanding of fundamental laws of thermodynamics to complicated and intriguing heat and work related mechanisms . In addition, the course aims to establish an understanding of the applications of thermodynamics to practical engineering systems such as vapour and gas power plants, refrigeration and air conditioning system, combustion and reacting mixtures.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Identify the principles of vapour and gas power plants • Discriminate and employ thermodynamics principles in refrigeration and air conditioning system • Interpret combustion thermodynamics fundamentals • Examine the thermodynamics aspects in reacting mixtures

Learning Units	**LU 1: Introduction** - Review of thermodynamics. **LU 2: Vapour Power Plants** -Modeling and analyzing vapor. power system – Rankin cycle. Improving performance - Superheat and reheat- Improving performance - Regenerative power plants. **LU 3: Gas Power Plants** - Modeling and analyzing gas power system. Internal combustion engines - Otto and Diesel cycle. Gas turbine power plant and Brayton Cycle. Regenerative gas turbines. Ericsson and Stirling cycle. **LU 4: Refrigeration and Air-conditioning system** - Vapour compression refrigeration system. Absorption refrigeration and heat pump system. **LU 5: Gas mixtures and psychrometic applications** **LU 6: Combustion** - combustion fundamental and adiabatic flame temperature. Fuel Emissions. **LU 7: Reacting mixtures** – Reacting mixtures including balancing of product & reactance and fuel cell.	
Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	28
	Seminars	
	Laboratory based practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	35
	Assignment(s)	35
	Project(s) / Case Study	10
	Seminars/Presentations	
	Report(s)	
	Total	100

Resources	1. Moran, M.J., Shapiro, H.N., [2007], *Fundamentals of Engineering Thermodynamics,* 6th Edition, Willey. 2. Cengel, Y.A. & Boles, M.A.,[2005] *Thermodynamics: An Engineering Approach*, 5th Edition, McGraw-Hill, Inc. 3. Smith, J. M., Van Ness, H. C., & Abbott, M., [2004] Introduction to Chemical Engineering Thermodynamics, McGraw-Hill. 4. Easttop, T.D. & McConkey, A. [1993]. *Applied Thermodynamics for engineering technologies*, Addison-Wesley, 5th Edition. 5. Haywood, R.W. [1980]. *Analysis of Engineering Cycles.* Pergamon Press Ltd: University of Cambridge, UK. 3rd Edition.

Course Code	**KNC 2142**
Course Title	**Environmental Engineering**
Course Credit	2 hrs
Type of Course	Core / Complimentary
Requisites	None
Instructor	
Courses Synopsis	The course introduces the students with water quality management and various treatment processes of wastewater. It also covers air pollution and noise pollution. Students are exposed to solid waste and treatment methodologies of this type of waste. Finally, the course covers on issues of environmental assessment.
Course Aims	Provide students with environmental engineering knowledge that includes water, air and solid waste management and treatment as well as the environmental assessments.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Identify Environmental Regulations and Legislation. • Differentiate the classification of wastes. • Analyze management of wastes. • Apply waste treatment technologies. • Evaluate Environmental Assessments.

Learning Units	**LU 1: Introduction** - Introduction to environmental engineering, environmental ethics, legislation and regulation. **LU 2: Water Quality Management** - Water Pollutants and Their Sources, water management in rivers and lakes. **LU 3: Wastewater Treatment** - Coagulation, Softening, Reactors, Mixing and Flocculation, Sedimentation, Filtration, Disinfection, Adsorption, Aerobic and Anaerobic treatment, Water Plant Waste Management. **LU 4: Air Pollution** - Physical and Chemical fundamentals, air pollution perspective and standards, effects of air pollutants, origin and fate of air pollutants, micro and macro air pollution, air pollution meteorology, atmospheric dispersion, indoor air quality model, air pollution control of stationery sources, air pollution control of mobile sources, waste minimization. **LU 5: Noise Pollution** - Effect of noise on people and noise control. **LU 6: Solid Waste** - Classification of solid waste – municipal, industrial and hazardous waste, solid waste management, treatment technologies. **LU 7: Environmental Assessment** - Legislative requirements, environmental impact, assessment preparation and review.	
Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	
	Seminars	
	Laboratory based practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	35
	Assignment(s)	35
	Project(s) / Case Study	10
	Seminars/Presentations	
	Report(s)	
	Total	100

Resources	1. H.S., Peavy, D.R., Rowe, Tchobanoglous, G., [2003] *Environmental Engineering,* Mcraw-Hill. 2. D.A., Cornwell, M.L.. Davis,[2002] *Environmental Engineering Mechanics,*, McGraw Hill 3. R.A., Corbitt, [2002], *Standard Handbook of Environmental Engineering*, McGraw- Hill.

Course Code	**KNC 2151**
Course Title	**Chemical Engineering Laboratory 2**
Course Credit	1 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	The course covers sampling, chemical equilibria in solution with particular emphasis on acid-base, precipitation, redox and complex formation reactions. It also includes solution of simple equilibrium problems and chemical behaviour of the most common elements. It introduced basic principles of chromatography and instrumental methods.
Course Aims	Aim of the course is to develop students' laboratory skills on developing experimental techniques. The course also illustrates, with concrete examples, the concepts that are introduced in the lectures.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Demonstrate laboratory skills in developing experimental techniques involving both organic and analytical chemistry • Explain most of organic chemistry problems • Relate theory of chemistry to laboratory problems • Demonstrate team work through group-based laboratory work • Express their findings from the experiments conducted in the form of report writing

Learning Units	The student will undergone laboratory practice on the suggested topics below: **LU 1:** Chemical Bonding **LU 2:** Alkanes and Cycloalkanes **LU 3:** Organic Chemical Reactions **LU 4:** Alkenes, Alkadienes and Alkynes Structure and Preparations. **LU 5:** Alkenes, Alkadienes and Alkynes Reactions **LU 6:** Arenes and Aromaticity **LU 7:** Stereochemistry **LU 8:** Nucleophilic Substitution Reactions **LU 9:** Spectroscopy **LU 10:** Alcohols, Esters and Phenols **LU 11:** Electroanalytical Methods **LU 12:** Chromatography Methods **LU 13:** Intrumental Methods **LU 14:** Evaluation of experimental data	
Teaching - Learning Approach		**Hours per semester**
	Lectures	
	Tutorials	
	Seminars	
	Laboratory based practical	28
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	
	Final Test	

	Assignment(s)	
	Project(s)	
	Seminars/Presentations	
	Report(s)	100
	Total	100

Resources

1. Bettelheim, F.A., [2005], *Introduction to Organic and Biochemistry*, 6th Edition, Sauders College Publishing, Orlando, Florida
2. Nechratal, A. & Tedder, J.M., [2004], *Basic Organic Chemistry, A Mechanistic Approach,* 7th Edition, John Wiley & Sons, Chichester, EnglandDouglas A.Skoog, [2004], *Fundamentals of Analytical Chemistry*, 8th edition, Prentice Hall
3. Christian, G.D.,[2003] *Analytical Chemistry*, Willey and Sons,
4. Harvey, D.,[2002] *Modern Analytical Chemistry*, MacGraw-Hill
5. Morrison R.T & Boyd R.N., [2002], *Organic Chemistry,* 8th Edition, Prentice Hall International, New Jersey
6. Loudon, G.M., [2002], *Organic Chemistry,* McGraw Hill, New York
7. Bard, A.J., Faulkner, L.R., [2000], *Electrochemical Methods: Fundamental and Application,* Willey

Course Code	**KNC 2162**
Course Title	**Chemical Unit Operations I**
Course Credit	2 hrs
Type of Course	Core
Requisites	None
Instructor	
Courses Synopsis	The course provides knowledge on transportation and metering of fluids and agitation and mixing of fluids. It also covers the heat transfer principles and heat exchange equipment. Students are also exposed to evaporation process, size reduction and fluid/particle mechanics.
Course Aims	To introduce the concept of a process as a series of unit operations. To introduce the common unit operations based on heat transfer and fluid/particle interactions. To provide a thorough grounding in the unit operation of heat transfer and fluid/particle interaction.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Define general concepts of chemical engineering equipments and fittings • Identify the basic knowledge and principles of chemical engineering. • Select the best equipment related to its process function. • Develop the optimal design of equipment.

Learning Units	**LU 1: Transportation and Metering of Fluids** – General concepts and design criteria for pipes, fittings and valves, fluid moving machinery e.g. pumps, fans, blower and measurement of flowing fluids. **LU 2: Agitation and Mixing of Fluids** – Agitation of liquids, circulation, velocities and power consumption in agitated vessels, suspension of solid particles. **LU 3: Heat Transfer Principles** – Conduction, Heat transfer coefficient, heat transfer to fluid with and without phase change, radiation heat transfer. **LU 4: Heat Exchange Equipment** – Design principles of heat exchanger, condenser and boiler. Heat transfer in agitated vessels, scraped surface exchangers, heat transfer in packed beds. **LU 5: Evaporation** – Types of evaporator, single and multiple effect operation, mass and energy balances on evaporators, boiling point rise due to solute, enthalpy/concentration diagrams. **LU 6: Size Reduction** – Principles of commination (milling operation), size reduction equipment and its operation. **LU 7: Fluid / particle Mechanics** – Particle properties and sizing, settling of particles in a fluid, Stokes Law, Hindered settling, design of settling tanks, thickeners.	
Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	
	Seminars	
	Laboratory based practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	35
	Assignment(s)	45

	Project(s)	
	Seminars/Presentations	
	Report(s)	
	Total	100
Resources	1. Cherememisinof, N.P., [2006], *Handbook of Chemical Process Equipment,* Butterworth-Heineman. 2. McCabe, W.I. & Smith, J.C., [2004], *Unit Operations of Chemical Engineering*,7th Edition, McGraw Hill. 3. Coulson,J.M., Richardson, J.F., Backhurst, J. & Harker, J., [2003], *Chemical Engineering, Volume 2 6th Edition*, Pergamon 4. Sinnott, R.K., [2002] *Chemical Engineering, Volume 6, revised 4th Edition*, Heinemann 5. Perry, R.H. & Green, D.W., [1999], *Perry's Chemical Engineering Handbook* 6th *Edition,* McGraw Hill	

Course Code	**KNC 2173**
Course Title	**Transport Process**
Course Credit	3 hrs
Type of Course	Core
Requisites	None
Instructor	
Courses Synopsis	The course covers single-phase phenomena and balance principles in transport process. It also introduces constitutive behavior of fluids and dimensional reasoning in engineering analysis. It covers both steady state and unsteady state non-uniform models. Finally, students are exposed to inter-phase transport phenomena and convection.
Course Aims	To introduce the concept of fluid transport process relevant to chemical industry.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Describe the microscopic mass, energy and momentum balances. • Interpret the value for necessary transport properties. • Apply microscopic balances for different physical systems to obtain practical information.

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Learning Units	**LU 1: Single-Phase Phenomena** - Low Reynolds number. High Reynolds number. **LU 2: Balance Principles** - Momentum. Energy. Mass **LU 3: Constitutive Behavior Of Fluids** - Newton's law of viscosity. Fourier's law of heat conduction Fick's law of diffusion. Non-Newtonian phenomena. **LU 4: Dimensional Reasoning In Engineering Analysis** **LU 5: Steady State, Spatially Non-Uniform Models** - Analytical and numerical solution methods (successive substitution). Boundary conditions. Analytical and numerical methods (shooting techniques and relaxation methods). **LU 6: Unsteady State, Spatially Non-Uniform Models** - Initial conditions. Boundary conditions. Analytical methods (similarity and eigenfunction expansion). Numerical methods (explicit finite differences). **LU 7: Interphase Transport Phenomena** - Friction factor. Heat transfer coefficient. Mass transfer coefficient. Interfacial tension. **LU 8: Convection** - Forced convection. Diffusion-induced convection. Natural convection.

Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	28
	Seminars	
	Laboratory based practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	35
	Assignment(s)	35
	Project(s) / Case Study	10
	Seminars/Presentations	
	Report(s)	
	Total	100

Resources	1. Cherememisinof, N.P., [2006],*Handbook of Chemical Process Equipment,* Butterworth-Heineman 2. McCabe, W.I. & Smith, J.C., [2004], *Unit Operations of Chemical Engineering*,7th Edition, McGraw Hill 3. Coulson,J.M., Richardson, J.F., Backhurst, J. & Harker, J., [2003], *Chemical Engineering, Volume 2 6th Edition,* Pergamon 4. Sinnott, R.K., [2002] *Chemical Engineering, Volume 6, revised 4th Edition*, Heinemann 5. Perry, R.H. & Green, D.W., [1999], *Perry's Chemical Engineering Handbook* 6th *Edition,* McGraw Hill

Course Code	**KNC 2182**
Course Title	**Occupational Safety and Health**
Course Credit	2 hrs
Type of Course	Core
Requisites	None
Instructor	
Courses Synopsis	Safety Laws - CIMAH (UK), OSHA (US), Types of hazards - Chemical, Mechanical, Electrical, Corrosion, Fire, explosion, Flammable and Toxic Material, Hazard identification – HAZOP, Hazard Assessment – Fault Tree Analysis, Hazard Control, Source Model, Toxic Release & Dispersion Model, Industrial Hygiene, Safety Management.
Course Aims	Provide students with process safety engineering areas, which cover the law, codes and standards for industrial safety, types of hazards, hazard identification and assessment and hazard control. The subject is also aimed to give awareness of the importance of safety elements through case studies.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • List and discuss the safety laws, codes and standards for safety engineering. • Recognize and interpret the types of hazards. • Examine hazard identifications and assessments. • Produce a control design for identified hazard problems. • Discuss and employ the principles of industrial hygiene. • Correlate the importance of safety management element in chemical engineering industry. • Communicate their view through presentation and discussions.

Learning Units	**LU 1: Law, Codes and Standard for Safety Engineering** - The Health and Safety at work etc. Act., Legislation on the control of major hazards, Safety standards and codes practices. **LU 2: Classification of hazards** - Chemical, Electrical, Mechanical, and Corrosion hazards, Flammable & Toxic Materials, Fire & Explosion. **LU 3: HAZOP** - A tool for hazard identification using guidewords. **LU 4: Fault Tree Analysis** - A tool for hazard assessment. **LU 5: Hazard Control**- Maintenance, Protective system and design of instrumentation for control and safety, disposal of released fluid. **LU 6: Source Models, Toxic release and dispersion Models.** - Flow of liquid and vapor through holes and pipes, Pasquill-Gifford Model or other dispersion model. **LU 7: Industrial Hygiene** - Government regulations, identification of hazardous material (MSDS), hazard evaluation and control. **LU 8: Safety Management** - Management's responsibility for health and safety, training for workers, protection cloths and devices, emergency planning.	
Teaching - Learning Approach		**Hours per semester**
	Lectures	20
	Tutorials	
	Seminars	16
	Laboratory based practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	35
	Assignment(s)	15

	Project(s) / Case Study	20
	Seminars/Presentations	10
	Report(s)	
	Total	100
Resources	1. Popendorf, W., [2006], Industrial Hygiene Control of Airborne Chemical Hazards, CRC press 2. Mannan, S., [2005], Lees' Loss Prevention in the Process Industries: Hazard Identification, Assessment and Control, 3rd Edition, Butterworth-Heinemann Ltd 3. Sanders, R.E., [2004], *Chemical Process Safety: Learning From Case Histories,* 3rd Edition, Butterworth Heinemann. 4. Nalven, G. F., [2003], *Plant Safety*, AIChem. 5. Crowl, D. A., Louvar, J. F., [2002] *Chemical Process safety*, 2nd Edition, Prentice Hall. 6. King, R., [2001], Safety *in the Process Industries,* Butterworth Heinemann.	

Course Code	**KNC 2193**
Course Title	**Separation Process and Particle Technology**
Course Credit	3 hrs
Type of Course	Core
Requisite	None
Instructor	
Course Synopsis	The course covers the introduction and fundamentals principles of phase equilibrium relationships. It covers the principles of multistage contacting, vapour/liquid equilibria, binary component, liquid/liquid equilibria, cross and counter-currents extractions. It also includes various separation process equipments.
Course Aims	The aim is to introduce the application of fundamental principles of phase equilibria to the design and operation of stage wise separation processes, with examples being drawn from distillation and solvent extraction.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Identify the basic features of a broad range of separation processes. • Describe the phase rule to a range of phase equilibria. • Calculate the binary and multicomponent bubble and dew point. • Analyze for optimum reflux ratios and optimum solvent to feed ratios.

Learning Units	**LU 1: Introduction** - Overview of available separation processes. **LU 2: Fundamental principles of phase equilibrium relationships** - the phase rule, Principles of steady state single stage mass balancing. **LU 3: Principles of multistage contacting** - cross-current and counter current contacting. **LU 4: Vapour/liquid equilibria** - ideal and non-ideal liquid systems; binary phase diagrams, Bubble and dew point calculations; binary and multicomponent. **LU 5: Binary component** - isothermal flash distillation, multistage distillation with constant molal overflow, Reflux ratio, total, minimum and economic reflux ratios, Selection of distillation column pressure, Multiple feed and side streams. **LU 6: Liquid/liquid equilibria** - choice of solvent; ternary phase diagrams. **LU 7: Cross and counter current extractions** - minimum and economic solvent ratio. **LU 8: Multi-component distillation methods**- Multi-component isothermal and adiabatic flash calculations, Non-isothermal, non equimolal overflow, stage wise distillation calculations, Convergence methods for steady state multistage multi-component systems, Short-cut design methods for steady state multistage multi-component systems. **LU 9: Azeotropic and extractive distillation** **LU 10: Batch distillation**- calculations and control, Selection and design of distillation trays. **LU 11: Fick's first and second laws** – single and multidimensional. **LU 12: Equimolar counter diffusion** – diffusion through a stagnant film.

	LU 13: Mass transfer models – two-film, penetration, Higbie-Danckwerts. **LU 14: Dimensionless groups** – correlations for mass transfer coefficients. **LU 15: Selection of continuous contacting devices** **LU 16: Transfer unit theory** – application to distillation, absorption, stripping and extraction. **LU 17: Absorption with chemical reaction**	
Teaching-learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	28
	Seminars	
	Laboratory based Practical	
	Non-laboratory	
Assessments		**Percentage**
	Test(s)/Quizzes	20
	Final Test	35
	Assignment(s)	35
	Project(s) / Case Study	10
	Seminars/Presentations	
	Report(s)	
	Total	100

Resources	1. Seader, J. D. & Henley E. J., [2005], *Separation Processes Principles*, 8th Edition John Wiley and Sons, U.S. A 2. Christie J Geankoplis,[2003], *Transport Processes and Separation Processes,* 4th Edition, Mac-Graw Hill 3. Coulson, J. M. M. & Richardson, J. F., [2002], *Chemical Engineering: Particle Technology and Separation Processes, vol. 2 –4*, Butterworth-Heinemann 4. Perry, R.H. & Green, D.W., [1999], *Perry's Chemical Engineering Handbook* 6th *Edition,* McGraw Hill

Course Code	**KNC 2202**
Course Title	**Instrumentation Process**
Course Credit	2 hrs
Type of Course	Core
Requisites	
Instructor	
Course Synopsis	Instrumentation system transducer, Measurement of various different quantities such as force, displacement, pressure, temperature, etc., Measurement errors, Dynamics performance, Interface with computer and data logger. Open-loop and close-loop control, Block and Block Reduction diagrams and transfer function of physical systems, Transient and frequency response, Control system components, Digital control. Design of compensated feedback control systems.
Course Aims	The aim of this course is to introduce the student on the aspect of process and instrument control.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Define and apply the concepts of mathematical modeling of dynamics system. • Discuss the application and limitation of different sensors. • Interpret feedback control systems characteristics. • Examine and analyze the performance of control system. • Define and utilize digital control system and feedback compensation. • Apply control theory in engineering problems.

Learning Units	**LU 1: Mathematical Modelling of Dynamic Systems** - Laplace Transform, Mathematical modelling of lumped-parameter components, devices and systems. Linearisation of dynamic equations. Block and Block Reductions diagrams, transfer function, signal flow graphs. Mason's rule. **LU 2: Measurement and instrumentation** - Static and Dynamic performance characteristics. Transducers used for measurement of controlled variables. **LU 3: Feedback control systems characteristics** – Open and closed-loop transfer functions. Steady state errors. Characteristic equation of closed-loop control systems. Routh - Hurwitz Stability criterion. Design criteria. Disturbance Signals in a Feedback control systems. **LU 4: State Variable Models** - State variables of Dynamic systems, transfer functions from the state equation, state differential equations, time response and state transition matrix. Conversion of State-Space to transfer Function or vice-versa. Signal-Flow Graphs of State Equations. **LU 5: Analysis and Performance of the control systems** - Transient response and steady-state error. Impulse, step, ramp and sinusoidal inputs. Analysis of transfer function inputs. Effects of initial conditions. Frequency Response Characteristics. Performance of a second - order or higher - Order systems. Effects of poles and zeros. Effects of damping ratio. **LU 6: Control Systems Analysis and Design** - Frequency response Analysis, Polar Plots, Nyquist Stability Criterion, Bode and Nichols diagrams. Root locus Plots. Closed-loop systems response to disturbances with different Entry points. State variable feedback systems. Controllability and Observability. **LU 7: Digital control systems** - Computer based control systems. Modeling the Digital Computer. Z-transform, Transfer Functions, Stability, Steady-state Errors, Transient Response on the z-Plane, Nyquist / Shannon sampling-rate theorem. Effect of Poles and zeros. **LU 8: Feedback compensation.**

	LU 9: Pole placement by vector feedback. **LU 10: Digital compensation.** **LU 11: Design of compensated feedback control systems –** Phase - lead, Phase - lag and Lead - lag compensation network using Operational Amplifiers and electrical networks, Proportional-Integral-Derivative (PID) controllers. Design Approaches using Frequency Response or Root Locus.	
Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	
	Seminars	
	Laboratory based practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	35
	Assignment(s)	35
	Project(s) / Case Study	10
	Seminars/Presentations	
	Report(s)	
	Total	100

Resources	1. Dunn, W. C., [2005], *Fundamentals of Industrial Instrumentation and Process Control*, Mc Graw Hill, New York. 2. Bolton, W., [2004], *Instrumentation and Control Systems*, Butterworth-Heinemann Ltd 3. Dorf, R. C., Bishop, R. H., [2004] *Modern Control Systems*, 8th Edition, Longman 4. DiStefano, J. J., Stubberud, A. R., [2003]*Feedback and Control Systems*, 4th Edition, MacGraw-Hill 5. Nise, N. S., [2003], *Control Systems Engineering*, 4th Edition, Addison - Wesley Publishing Company 6. Liptak, B. G., [2003], *Instrument Engineers' Handbook: Process Measurement and Analysis Vol 1(Instruments Engineer's Handbook) 4th Edition*, CRC Press Inc. 7. Ogata, K., [2002] *Modern Control Engineering*, 3rd Edition, Prentice Hall International Editions. 8. Considine, D. M., and McMillan, G. K., [1999], *Process/Industrial Instruments and Controls*, McGraw-Hill, New York 9. Richardson, J. F., Coulson, J. M., Peacock, D. G., [1994], *Chemical and Biochemical Reactors and Process Control: Chemical and Biochemical Reactors and Process Control v. 3 (Chemical Engineering)*, Butterworth-Heinemann Ltd, London

Course Code	**KNC 2211**
Course Title	**Chemical Engineering Laboratory 3** **(Instrumentation and Process Control Lab)**
Course Credit	1 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	Topics covered in this course are related to instrumentation process and control such as typical process systems, process dynamics, control strategies, computer control strategies. Recent control techniques and modern trends.
Course Aims	To introduce the concept of instrumentation process and control as a series of unit operations.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Demonstrate laboratory skills in developing experimental techniques involving both theories in instrumentation process and control systems. • Correlate laboratory experiments from instrument process to control system concepts. • Analysis and model the process dynamics. • Formulate and implement an appropriate control strategy for a typical industrial process. • Demonstrate team work through group-based laboratory work • Express their findings from the experiments conducted in the form of report writing.

Learning Units	The students will undergo laboratory practice on the suggested topics below: **LU 1:** Flow Control **LU 2:** Level Control **LU 3:** Temperature Control **LU 4:** Pressure Control **LU 5:** Programmable logic Control **LU 6:** Automation/robotics **LU 7:** VR Robot Simulation **LU 8:** Other process controls which are relevant to chemical engineering and energy industries.	
Teaching - Learning Approach		**Hours per semester**
	Lectures	
	Tutorials	
	Seminars	
	Laboratory based practical	28
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	
	Final Test	
	Assignment(s)	
	Project(s)	
	Seminars/Presentations	
	Report(s)	100
	Total	100

Resources	1. Dunn, W. C., [2005], *Fundamentals of Industrial Instrumentation and Process Control*, Mc Graw Hill, New York. 2. Bolton, W., [2004], *Instrumentation and Control Systems*, Butterworth-Heinemann Ltd 3. Dorf, R. C., Bishop, R. H., [2004] *Modern Control Systems*, 8th Edition, Longman 4. DiStefano, J. J., Stubberud, A. R., [2003]*Feedback and Control Systems*, 4th Edition, MacGraw-Hill 5. Nise, N. S., [2003], *Control Systems Engineering*, 4th Edition, Addison - Wesley Publishing Company 6. Liptak, B. G., [2003], *Instrument Engineers' Handbook: Process Measurement and Analysis Vol 1(Instruments Engineer's Handbook) 4th Edition*, CRC Press Inc. 7. Ogata, K., [2002] *Modern Control Engineering*, 3rd Edition, Prentice Hall International Editions. 8. Considine, D. M., and McMillan, G. K., [1999], *Process/Industrial Instruments and Controls*, McGraw-Hill, New York 9. Richardson, J. F., Coulson, J. M., Peacock, D. G., [1994], *Chemical and Biochemical Reactors and Process Control: Chemical and Biochemical Reactors and Process Control v. 3 (Chemical Engineering)*, Butterworth-Heinemann Ltd, London

TAHUN 3

Course Code	**KNC 3223**
Course Title	**Chemical Unit Operations II**
Course Credit	3 hrs
Type of Course	Core
Requisites	None
Instructor	
Courses Synopsis	The course covers topics on distillation and multi component distillation. It includes chemical engineering processes such as leaching and extraction, gas absorption, humidification operations, drying of solids, adsorption. Students are also exposed to membrane separation process and crystallization process.
Course Aims	To introduce the common unit operations based on mass transfer principles and provide basis for design project modules. To provide a thorough grounding in the unit operation of mass transfer in relation to its equipment's.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Discuss mass transfer principles in a given separation process. • Differentiate between absorption and adsorption process. • Select appropriate crystalliser. • Design basic chemical engineering equipment for a simple chemical engineering problem.
Learning Units	**LU 1: Distillation** – Plate columns, fractionating columns, sieve-plate columns, Batch distillation, Vacuum, atmospheric and pressure operation, Batch columns, Importance of the reflux ratio, Calculation of minimum reflux ratio, Number of plates at total reflux, Underwood and Fenske equations, Selection of economic reflux ratio.

	LU 2: Multicomponent Distillation – Flash distillation of multicomponent mixtures, fractionation of multicomponent mixtures, azeotropic and extractive distillation, Effect of multiple feeds and side streams. **LU 3: Gas Absorption –** Design of packed towers, absorption in plate columns, and absorption with chemical reactions. **LU 4: Drying of Solids** – Batch and continuous drying, drying rate curves, constant and falling rate periods, time for drying, equilibrium moisture content, types of dryer. **LU 5: Adsorption** – Principles of adsorption and absorber design. **LU 6: Membrane Separation Process** – Principles and membrane selection. **LU 7: Crystallization** – Types of crystallisers and their selection need for further processing of product nucleation, growth rate and yield.

Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	28
	Seminars	
	Laboratory based practical	
	Non-laboratory	

Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	30
	Assignment(s)	30
	Project(s) / Case Study(s)	20
	Seminars/Presentations	
	Report(s)	
	Total	100

Resources	1. McCabe, W. L., [2005], *Unit Operations of Chemical Engineering*, McGraw Hill, New York. 2. Geankoplis, C. J., [2003], *Transport Processes and Separation Process Principles: Includes Unit Operations*, Prentice Hall, London. 3. Perry, R.H., Chilton, C. H., and Green, D.W., [1999], *Perry's Chemical Engineering Handbook 6th Edition,* McGraw Hill. 4. Sinnott, R.K., [1996] *Chemical Engineering, Volume 6, revised 2nd Edition*, Heinemann. 5. Coulson, J.M., Richardson, J.F., Backhurst, J. & Harker, J., [1991], *Chemical Engineering, Volume 2 4th Edition*, Pergamon.

Course Code	**KNC 3233**
Course Title	**Process Control Systems**
Course Credit	3hrs
Type of Course	Core
Requisites	KNC 2202 Instrumentation Process
Instructor	
Course Synopsis	Typical Process Systems, Process Dynamics, Control Strategies, Computer control strategies, Advanced Control techniques and Modern Trends in Control System.
Course Aims	The aim of this course is provide the student with the knowledge of control in machines and processes.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Identify and describe the characteristics of typical industrial processes. • Apply and evaluate process dynamics. • Design appropriate control strategies for a typical industrial process. • Describe and apply advanced control techniques in process control system. • Recognize and appraise modern trends in design and analysis of digital and analogue control system.
Learning Units	**LU 1: Review of basic control theory**- mathematical modelling, transfer function, block diagram. Mathematical modelling of physical systems. Stability of linear control systems. Root locus techniques. Time domain analysis. Frequency domain analysis.

	LU 2: Typical process systems - Types of Transducers, Temperature, flow, pressure, speed, level control. Multivariable control systems. Interaction and compensation. **LU 3: Process dynamics** - Process response, gain, dead-time, order, linearity, common non-linearity. Process modelling, identification and simulation. **LU 4: Control strategies** - Process disturbances and noise. Reduction of noise by means of hardware and software filters. Process regulation and target tracking. Three terms PID controller, analysis and design. Ziegler and Nichols methods for three term controllers tuning. Three term loop tuning. **LU 5: Computer control strategies** - Digital compensators - design and programming. Response prediction using difference equations, transient and stability analysis. Continuous control, discrete control, direct digital control, supervisory, distributed, batches control. Design of discrete control using Programmable logic controller, ladder diagrams and petri nets. **LU 6: Modern trends** - Design and analysis of digital and analogue control systems using simulation techniques. Digital-to-Analog conversion techniques, Analog-to-digital conversion techniques, Operational Amplifiers, Analog and Digital Signal Conditioning, Basic Architecture of microprocessors and microcomputers systems and its applications, Industrial monitoring and control hierarchies. Adaptive control schemes and self-tuning. Fuzzy control systems, expert systems and neural network control systems.

Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	28
	Seminars	
	Laboratory based practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	30
	Assignment(s)	30
	Project(s) / Case Study(s)	20

	Seminars/Presentations	
	Report(s)	
	Total	100
Resources	1. Dunn, W. C., [2005], *Fundamentals of Industrial Instrumentation and Process Control*, Mc Graw Hill, New York. 2. Bolton, W., [2004], *Instrumentation and Control Systems*, Butterworth-Heinemann Ltd 3. Dorf, R. C., Bishop, R. H., [2004] *Modern Control Systems*, 8th Edition, Longman 4. DiStefano, J. J., Stubberud, A. R., [2003]*Feedback and Control Systems*, 4th Edition, MacGraw-Hill 5. Nise, N. S., [2003], *Control Systems Engineering*, 4th Edition, Addison - Wesley Publishing Company 6. Liptak, B. G., [2003], *Instrument Engineers' Handbook: Process Measurement and Analysis Vol 1(Instruments Engineer's Handbook) 4th Edition*, CRC Press Inc. 7. Ogata, K., [2002] *Modern Control Engineering*, 3rd Edition, Prentice Hall International Editions. 8. Considine, D. M., and McMillan, G. K., [1999], *Process/Industrial Instruments and Controls*, McGraw-Hill, New York 9. Richardson, J. F., Coulson, J. M., Peacock, D. G., [1994], *Chemical and Biochemical Reactors and Process Control: Chemical and Biochemical Reactors and Process Control v. 3 (Chemical Engineering)*, Butterworth-Heinemann Ltd, London	

Course Code	**KNC 3243**
Course Title	**Chemical Reaction Process**
Course Credit	3 hrs
Type of Course	Core
Requisites	None
Instructor	
Courses Synopsis	The course covers in depth study about the effect of reaction heat, temperature and pressure in a process, non-ideal flow, and heterogeneous systems. It covers the analysis of reaction in various component mixing and systems such as the non-catalytic system and biochemical reaction system.
Course Aims	Provide students with deeper knowledge of designing the optimum chemical reactors for a process taking into account several factors such as thermodynamics, chemical kinetics, fluid mechanics, heat transfer, mass transfer and economics.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Describe the effect of heat of reactions in single reactions, multiple reactions, adiabatic operations and non-adiabatic operations. • Understand the term of residence time distribution of fluid in vessels and models for non-ideal flow. • Design for heterogeneous reacting systems. • Analyze the reaction of different component of mixing.
Learning Units	**LU 1: Temperature and Pressure Effects** – Study on how equilibrium yield, rate of reaction and product distribution are affected by changes in operating temperatures and pressures, thus to determine the temperature progression.

	LU 2: Flow Patterns, Contacting and Non-Ideal Flow – Basics of Non-Ideal Flow, The dispersion model, the tanks-in-series model, the convection model for laminar flow, earliness of mixing, segregation and RTD. **LU 3: Reactions Catalyzed by solids** – Heterogeneous Reactions, Solid Catalyzed Reactions, The packed Bed Catalytic Reactor, Reactors with suspended solid catalyst, fluidized reactors of various types, deactivating catalysts, reactions on solid catalyst: trickle beds, slurry reactors, three-phase Fluidized beds **LU 4: Non-Catalytic system** – Fluid-fluid Reactions: kinetics, fluid-fluid reactor design, fluid-particle reactions-kinetics, fluid-particle reactor design. **LU 5: Biochemical Reaction System** – Enzyme Fermentation, Microbial Fermentation, Substrate-limiting microbial fermentation, product-limiting microbial fermentation.

Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	28
	Seminars	
	Laboratory based practical	
	Non-laboratory	

Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	30
	Assignment(s)	30
	Project(s) / Case Study(s)	20
	Seminars/Presentations	
	Report(s)	
	Total	100

Resources	1. Fogler, H. S., [2004], *Elements of Chemical Reaction Engineering (Prentice-Hall International Series in the Physical & Chemical Engineering Sciences) 4th Edition,* Prentice Hall, New York.

2. Perry, R.H., Chilton, C. H., and Green, D.W., [1999], *Perry's Chemical Engineering Handbook 6th Edition,* McGraw Hill

3. Levenspiel, Q., [1998], *Chemical Reaction Engineering,* John Wiley & Sons, New York

4. Richardson, J. F., Coulson, J. M., Peacock, D. G., [1994], *Chemical and Biochemical Reactors and Process Control: Chemical and Biochemical Reactors and Process Control v. 3 (Chemical Engineering),* Butterworth-Heinemann Ltd, London

Course Code	**KNC 3253**
Course Title	**Process Design**
Course Credit	3 hrs
Type of Course	Core
Requisites	None
Instructor	
Courses Synopsis	Basic concepts and techniques of modeling and simulation, analysis and design of chemical process components - distillation column, absorption tower, extraction column, heat exchanger, material and energy balances, complete simulation analysis of chemical process plant.
Course Aims	Provide students with basic and up-to-date concepts on the techniques for modeling and simulation of chemical process, with the estimation of parameters and control, as well as with aspects of the implementation of these different techniques.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Identify the general formulation of the modeling concepts. • Define and apply techniques of modeling and simulation. • Analyze the chemical process components. • Construct simulation of chemical process plant.
Learning Units	**LU 1: Introduction to Process Modelling** - Developing models, simulation system, linear system analysis, and numerical Analysis. **LU 2: Analysis of Process Modelling** - Balance Equation-integral balances, instantaneous balances, Material balances –

	simplifying assumptions, Constitutive Relationship – Gas Law, Chemical Reactions, Equilibrium Relationship, Flow-through Valves, Material and Energy Balances – Review of Thermodynamics, Distributes Parameter Systems, Dimensionless Models, Explicit Solutions to Dynamics Models, General Form of Dynamic Models. **LU 3: Numerical Techniques** - Algebraic Equations – notations, general form for a linear system of equations, nonlinear functions of a single variable, MATLAB routines for solving functions of a single variable, multivariable systems – Newtons and Quasi-Newton methods, Numerical Integration – Euler Integration, Runge Kutta Integration, MATLAB Integration Routines. **LU 4: Distillation** - Introduction, thermodynamic models, Design of continuous column, Continuous column simulation, batch distillation. **LU 5: Liquid-liquid Extraction** - Description and classification of extraction columns, Column modeling and simulation. **LU 6: Absorption** - Absorption analysis and modeling. Packed columns, plate column, stripping. **LU 7: Heat Exchangers** - Description and selection of heat exchangers, basic principle of heat exchangers, modeling of heat exchangers for single-phase flow, condensers and reboilers. **LU 8: Computer-Aided Design Programs** - General Structure of Computer-Aided Design Programs, complete plant simulation.

Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	28
	Seminars	
	Laboratory based practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	30
	Assignment(s)	30

	Project(s) / Case Study(s)	20
	Seminars/Presentations	
	Report(s)	
	Total	100

Resources

1. Smith, R., [2005], *Chemical Process Design: For the Efficient Use of Resources*, John Wiley and Sons Ltd, London.

2. Silla, H., [2003], *Chemical Process Engineering: Design and Economics (Chemical Industries Series)*, Marcel Dekker Ltd.

3. Speight, J. G., [2001] *Handbook of Chemical Process and Design* McGraw-Hill, New York.

4. Perry, R.H., Chilton, C. H., and Green, D.W., [1999], *Perry's Chemical Engineering Handbook 6th Edition,* McGraw Hill.

5. Levenspiel, Q., [1998], *Chemical Reaction Engineering,* John Wiley & Sons, New York.

6. Biegler, L. T., [1997], *Systematic Methods for Chemical Process Design (Prentice Hall International Series in the Physical and Chemical Engineering Sciences)*, Prentice Hall, New York.

Course Code	**KNC 3262**
Course Title	**Polymer for Energy Application**
Course Credit	2 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	The course covers fundamental knowledge on polymer synthesis as well as chemical and physical properties such as viscoelasticity. It includes application of polymer as alternate material for photovoltaic cell (PV). The course also covers polymer processing and degradation in environment. Finally, the course provides case study on polymer for energy application for discussion.
Course Aims	Knowledge of polymer is crucial for chemical engineers. This course will provide general background on the fundamental chemical and physical information on the synthesis, production and characterization of polymeric materials as well as introducing the breadth of polymer properties especially in alternate energy application area.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Define the fundamental chemical and physical information on the synthesis, production and characterization of polymeric materials. • Explain the polymer processing available in chemical industry. • Apply the fundamental of polymer properties for alternate energy application. • Analyze problems on energy efficiency by manipulating

	polymer chemical and physical properties.
Learning Units	**LU 1: Introduction** – classification of polymers, polymer structure, molecular weight, chemical structure and thermal transitions. **LU 2: Polymer Synthesis** – Step-growth Polymerization, Chain-growth Polymerization, Polymerization Technique, Reactions of Synthetic Polymer, Chemical Structure Determination. **LU 3: Conformation, Solutions and Molecular Weight** – Polymer Conformation and Chain Dimensions, Thermodynamics of Polymer Solutions, Measurement of Molecular Weight. **LU 4: Solid-state Properties** – The Amorphous State, Crystalline State, Thermal Transitions and Properties, Mechanical Properties. **LU 5: Viscoelasticity and Rubber Elasticity** – Dynamic Mechanical Analysis, Viscoelasticity Properties of Polymer Solutions and Melts, Dielectric Analysis, Time-Temperature Superposition, Introduction to Rubber Elasticity. **LU 6: Polymer Degradation and the Environment** – Thermal Degradation and Stability, Oxidative and UV Stability, Chemical and Hydrolytic Stability, Management of Plastics in the Environment. **LU 7: Additive, Blends and Composites** –Plasticizers, Fibre and Reinforcements, Polymer Blends and Interpenetrating Networks, Introduction to Polymer Composites. **LU 8: Polymer Processing** – Extrusions of Thermoplastics, Injection Moulding, Blow and Rotational Moulding, Thermal Forming and Calendering, Processing of Thermosetting, Processing of Reinforced Materials. **LU 9: Polymer For Energy Application: Case study 1**- Introduction to Photovoltaic Cell, Organic Photovoltaic, Conductive Electroactive Polymers, Conjugated Polymers and Molecular Interfaces. Case study on polymeric PV cell efficiency using different polymer film. **LU 10: Polymer For Energy Application: Case study 2** – Introduction to Fuel Cell, Polymer for fuel cell, Type of

	membranes and electrodes. Conjugated Polymers and Molecular Interfaces. Case study on fuel cell efficiency using different polymer type.	
Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	
	Seminars	
	Laboratory based practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	30
	Assignment(s)	30
	Project(s) / Case Study(s)	20
	Seminars/Presentations	
	Report(s)	
	Total	100
Resources	1. Wallace G.C, Spinks, [2002], *Conductive Electroactive Polymers, 2nd Edition,* CRC. 2. McCrum N.G, [2001], *Principles of Polymer Engineering, 4th Edition* , John Wiley & Sons 3. Joel, R.F., [2001], *Polymer Science and Technology, 6th Edition,* John Willey & Sons. 4. Arie, R., [1999], *Fundamentals of Polymer Engineering, 2nd Edition*, Plenum Press 5. Sallaneck, W.R., Seki.K , Khan, A, [1999] , *Conjugated Polymers and Molecular Interfaces,* CRC	

TAHUN 4

Course Code	**KNC 4273**
Course Title	**Energy Resources and Applications**
Course Credit	3 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	Examination of current and potential energy systems to enhance the student understanding of energy concept, covering energy resources, energy generation, energy system application and energy management. Investigate and analyze various energy-saving methods and industrial practices as well as to generate awareness of the recent advancements in alternative energies. Design of energy systems and prediction of their system efficiencies in case studies. This course will complement fluid mechanics and thermodynamics courses.
Course Aims	This course introduces total energy concept in relation to energy generation, sources, usage, energy efficiency and management. Also, it investigates and evaluates various energy saving methods and industrial practices as well as to generate awareness of the recent advancements in alternative energies.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Describe the total energy concept including energy resources, energy generation methods, energy system design, application and energy auditing and management. • Use design tool or software packages to solve practical energy problems and design for energy efficiency as well as industrial energy systems and applications. • Compare various energy resources and energy management issues. • Communicate effectively the results of their work, both

	orally and in formal written reports.
Learning Units	**LU 1: Introduction to energy and power** - Energy and power basics. Energy generation systems. Energy storage and methods. Energy efficiencies and losses. **LU 2: Energy sources study** - Sources of energy supply and energy demand. Sankey diagrams. **LU 3: Basic Energy management and analysis** - Energy audits. Fuel consumption study. Energy life-cycle Analysis. Energy saving. **LU 4: The technology of energy saving** - Energy recovery. Pinch technology. Combined cycles and combined power plant. Combined heat and power (CHP) (Co-generation). **LU 5: Conventional energy vs alternative energy** - Energy from fossil fuels (petroleum, natural gas & coal). Recent environment concern on fossil fuels. Introduction to alternative energy sources. **LU 6: Solar energy and electromechanical energy conversion** - Solar energy : solar photovoltaic (PV) and solar thermal energy electromechanical energy conversion: Fuel cell and batteries. **LU 7: Wind energy and hydro energy** - Wind energy. Hydro energy. Hybrid PV-Microhydro case study. **LU 8: Nuclear energy and waste energy** - Nuclear energy and nuclear power plant. Waste energy from Biomass. **LU 9: Other energy conversion** - Thermoelectric and Thermionic energy conversion and Magnetohydrodynamic (MHD) power conversion, etc.

Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	28
	Seminars	
	Laboratory based practical	
	Non-laboratory	

Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	30
	Assignment(s)	20
	Project(s)	20
	Seminars/Presentations	5
	Report(s)	5
	Total	100

Resources

1. Tiwari, G. N. and Ghosal, M. K., [2005], *Renewable Energy Resources; Basic Principles and Applications*, Alpha Science International Ltd, Haroow, Middlesex, UK.
2. Boyle, G., Everett, B., and Ramage, J., [2003], *Energy Systems and Sustainability*, Oxford University Press.
3. Burton, T., Sharpe, D., Jenkins, N., and Bossanyi, E,[2001], *Wind Energy Handbook,* John Wiley and Sons.
4. Larmanie, J. and Dicks, A. [2001] Fuel Cell Systems Explained. John Wiley.
5. Khartchenko, N. V., [1997], *Advanced Energy Systems (Applied Energy Technology)*, Taylor & Francis Inc.
6. Eastop & McConkey. [1993]. Applied Thermodynamics for engineering technologist. Longman Group. 5th Edition.
7. Archie, W.C., [1991]. Principles of Energy conversion. Mc-Graw Hill, Series in Mechanical Engineering.
8. Oman H., [1986]. Energy System Engineering Handbook. Prentice-Hall.

Course Code	**KNC 4283**
Course Title	**Quality Control & Reliability**
Course Credit	3 hrs
Type of Course	Core
Requisites	
Instructor	
Course Synopsis	The course covers basic concepts for quality control and various quality control tools. Students are also exposed to quality assurances concept such as Statistical Process Control (SPC), TQC and TQM. It covers sampling process, sampling error and acceptance sampling and inspection.
Course Aims	To provide students with knowledge of the basic concept knowledge of quality control, Total Quality Control (TQC) and Total Quality Management (TQM).
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Determine the concept of quality control. • Propose usage of quality control tools. • Assess the concept of TQC and TQM. • Practice good quality assurance concepts
Learning Units	**LU 1: Basic Concepts for Quality Control** – History of quality, What is quality?, What is quality control?, The quality control system, Inspection and Testing. **LU 2: Quality Control Tools** – Histograms, Cause and Effect Diagram, Check Sheets, Pareto Diagrams, Graphs, Control Charts, Scatter Diagrams.

	LU 3: Statistical Process Control (SPC) Concept – Variable control charts, Attribute control charts, Process capability. **LU 4: Acceptance Sampling and Inspection** – Acceptance sampling, Sampling Plan, Operating Characteristic Curves (OC Curves), Acceptable Quality Level (AQL), Limiting Quality Level (LQL), Average Outgoing Quality (AOQ), Average Outgoing Quality Limit (AOQL), Producer's risk, Acceptance number, reject number. **LU 5: TQC and TQM** – Basic concept of TQC & TQM, Implementation issues for TQC & TQM,	
Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	28
	Seminars	
	Laboratory based practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	30
	Assignment(s)	30
	Project(s)	20
	Seminars/Presentations	
	Report(s)	
	Total	100

Resources	1. Smith, D. J., [2004], *Reliability, Maintainability and Risk: Practical Methods for Engineers*, Butterworth-Heinemann Ltd 2. O'Connor, P.D.T., [2002], *Practical Reliability Engineering*, John Wiley and Sons Ltd 3. Dodson, B. and Nolan, D.,[1999], *Reliability Engineering Handbook (Quality & Reliability)*, Marcel Dekker Ltd 4. Bentley J. P., [1993] *Introduction to Reliability and Quality Engineering*, Longman 5. Ramakumar R, [1993] *Engineering Reliability. Fundamentals and Applications*, Prentice Hall 6. Moss, M.A., [1985] *Designing For Minimal Maintenance Expenses*, Marcel Dekker.

Course Code	**KNC 4294**
Course Title	**Chemical Plant Design**
Course Credit	4 hrs
Type of Course	Core
Requisites	KNC 3243 Process Design
Instructor	
Course Synopsis	An interdisciplinary team-based design final-year course, where each student works as part of a team on an engineering project. The course based on the 'total design' concept, consists of a number of chemical engineering design activities, based on few (2) case studies. All aspects of the design of a new chemical/energy product, service or process are of concern: customer need, product function, product form, technical design, manufacturing, human interface design, impact on society and sustainability. Projects will only last for one semester. These projects are suggested or supported by local industry or government agency.
Course Aims	The goal for this course is to give students experience by working with industry on real engineering design problems.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Demonstrate and operate as team especially on interdisciplinary team-based. • Develop solutions as part of a team, as well as undertaking individual technical effort in achieving them. • Apply their knowledge in chemical engineering in solving open-ended technical problems. • Formulate, organize and assess their strategies in solving actual problems.

<table>
<tr><td></td><td colspan="2">• Produce technical reports on the design work carried out.
• Assess time-management skills due to report and presentation deadlines being imposed.</td></tr>
<tr><td>Learning Units</td><td colspan="2">The phases of design:

Phase 1: students undertake two case study projects working in small groups (usually pairs). Each case study typically entails the design of a single unit operation, for example a heat exchanger, reactor or distillation column. The case studies, which are carried out sequentially, are followed subsequently by Phase 2.

Phase 2: Group design project which is carried out in larger groups and generates the preliminary process design and costing of a complete plant. Stress is laid on effective teamwork and communication both within the group and to a wider audience of staff, fellow students and industrial visitors.</td></tr>
<tr><td rowspan="5">Teaching-learning Approach</td><td></td><td>Hours per semester</td></tr>
<tr><td>Lectures</td><td>42</td></tr>
<tr><td>Tutorials</td><td></td></tr>
<tr><td>Seminars</td><td>28</td></tr>
<tr><td>Laboratory based Practical</td><td></td></tr>
<tr><td></td><td>Non-laboratory</td><td></td></tr>
<tr><td rowspan="7">Assessment</td><td></td><td>Percentage</td></tr>
<tr><td>Test(s)/Quizzes</td><td></td></tr>
<tr><td>Final Test</td><td></td></tr>
<tr><td>Assignment(s)</td><td>30</td></tr>
<tr><td>Project(s)</td><td>40</td></tr>
<tr><td>Seminars/Presentations</td><td>20</td></tr>
<tr><td>Report(s)</td><td>10</td></tr>
<tr><td></td><td>Total</td><td>100</td></tr>
</table>

Resources

1. McCabe, W. L., [2005], *Unit Operations of Chemical Engineering*, McGraw Hill, New York.

2. Smith, R., [2005], *Chemical Process Design: For the Efficient Use of Resources*, John Wiley and Sons Ltd, London.

3. Wiley –VCH, [2004], *Ullmann's Chemical Engineering and Plant Design,* John Wiley and sons.

4. Silla, H., [2003], *Chemical Process Engineering: Design and Economics (Chemical Industries Series)*, Marcel Dekker Ltd.

5. Peters, M. S., Timmerhaus, K. D., and West, R, E. , [2003], *Plant Design and Economics for Chemical Engineers,* McGraw Hill Higher Education.

6. Geankoplis, C. J., [2003], *Transport Processes and Separation Process Principles: Includes Unit Operations*, Prentice Hall, London.

7. Peters, M. S., Timmerhaus, K. D., and West, R, E. , [2002] *Plant Design Chemical Engineers 5th edition*, McGraw-Hill.

8. Speight, J. G., [2001] *Handbook of Chemical Process and Design* McGraw-Hill, New York.

9. Doherty, M. F., And Malone, M. F., [2001], *Conceptual Design of Distillation System*, New York: McGraw-Hill Inc.

10. Perry, R.H., Chilton, C. H., and Green, D.W., [1999], *Perry's Chemical Engineering Handbook 6th Edition,* McGraw Hill.

11. Upper Saddle River, [1998], *Analysis, Synthesis, and Design Of Chemical Processes* , N.J.: Prentice Hall PTR.

12. Biegler, Lorenz T., [1997], *Systematic Methods Of Chemical Process Design*,Upper Saddle River, N.J. : Prentice Hall PTR.

13. Sinnott, R.K., [1996] *Chemical Engineering, Volume 6, revised 2nd Edition*, Heinemann.

Course Code	**KNC 4301**
Course Title	**Chemical Engineering Laboratory 4**
Course Credit	1 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	The course covers experimental activities on various separation processes available in chemical engineering process. It also includes laboratory practices on chemical kinetics and chemical reactions. Finally, students are exposed to chemical analysis of batch reactor of constant and different volume.
Course Aims	The aim of this course is provide the student with the knowledge of control in machines and processes.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Classify different chemical separation processes and reactions. • Select the best equipment related to its process function. • Develop optimal design of equipment. • Interpret data obtained in experimental activities. • Develop team work through group based experimental exercises.
Learning Units	The student will undergone laboratory practice on the suggested topics below: **LU 1:** Distillation **LU 2:** Leaching and extraction

	LU 3: Absorption **LU 4:** Crystallization **LU 5:** Evaporation **LU 6:** Size Reduction **LU 7:** Kinetics of homogeneous reactions **LU 8:** Interpretation of batch reactor data **LU 9:** Reactor Design for single ideal reactors **LU 10:** Design for single reaction **LU 11:** Design for multiple reactions **LU 12:** Temperature and Pressure Effects **LU 13:** Flow Patterns, Contacting and Non-Ideal Flow **LU 14:** Reactions Catalyzed by solids **LU 15:** Non-Catalytic system **LU 16:** Biochemical Reaction System

Teaching - Learning Approach		**Hours per semester**
	Lectures	
	Tutorials	
	Seminars	
	Laboratory based practical	28
	Non-laboratory	

Assessment		**Percentage**
	Test(s)/Quizzes	
	Final Test	
	Assignment(s)	
	Project(s)	
	Seminars/Presentations	
	Report(s)	100
	Total	100

Resources	1. McCabe, W. L., [2005], *Unit Operations of Chemical Engineering*, McGraw Hill, New York 2. Fogler, H. S., [2004], *Elements of Chemical Reaction Engineering (Prentice-Hall International Series in the Physical & Chemical Engineering Sciences) 4th Edition*, Prentice Hall, New York. 3. Geankopolis, C. J., [2003], *Transport Processes and Separation Process Principles: Includes Unit Operations*, Prentice Hall, London 4. Perry, R.H., Chilton, C. H., and Green, D.W., [1999], *Perry's Chemical Engineering Handbook 6th Edition*, McGraw Hill 5. Levenspiel, Q., [1998], *Chemical Reaction Engineering*, John Wiley & Sons, New York 6. Sinnott, R.K., [1996] *Chemical Engineering, Volume 6, revised 2nd Edition*, Heinemann 7. Richardson, J. F., Coulson, J. M., Peacock, D. G., [1994], *Chemical and Biochemical Reactors and Process Control: Chemical and Biochemical Reactors and Process Control v. 3 (Chemical Engineering)*, Butterworth-Heinemann Ltd, London 8. Coulson, J.M., Richardson, J.F., Backhurst, J. & Harker, J., [1991], *Chemical Engineering, Volume 2 4th Edition*, Pergamon

Course Code	**KNC 4312**
Course Title	**Final Year Project I**
Course Credit	2 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	It is expected that each student will be assigned to an individual project that may be internally generated; or an industrial collaboration that may require any of the following: literature search, equipment design/modification/build/test, experimental programme design and validation, data collection and analysis, group collaboration on design/analysis/results, assessment of success/further work/conclusions, use of industrial research/development facilities.
Course Aims	To educate the student utilizing the resources available in the faculty and the library in order to gather sufficient information and identify ways of solving a selected engineering research topics.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Select the relevant information available in a coherent manner. • Analyze data such that the aims of the project may be satisfies. • Discuss and communicate with lecturers or other researchers. • Compare expected project findings with findings already available in literature. • Write an initial report or research proposal towards the end of 14 week for initial evaluation.

<table>
<tr><td></td><td colspan="2">• Orally present the research proposal for 10-15 minutes, and answer questions arises during the oral presentation.</td></tr>
<tr><td>Learning Units</td><td colspan="2">LU 1: Source of information and literature search - Method, Result and findings from book, monograph, Handbook, Journals and research papers.

LU 2: The project proposal -Aims and objective, project work and experimental design.

LU 3: Experimentation or/and modeling - Experimental method. Experimental design. Modeling equations. Computer codes.

LU 4: Data collection and analysis - Data collection from experiments and modeling. Analysis of data. Errors in data.

LU 5: Reporting -Report writing and presentation.

LU 6: References and bibliographies - References writing from book, monographs, handbook, journals and research papers.</td></tr>
<tr><td rowspan="6">Teaching - Learning Approach</td><td></td><td>Hours per semester</td></tr>
<tr><td>Lectures</td><td></td></tr>
<tr><td>Tutorials</td><td></td></tr>
<tr><td>Seminars</td><td>6</td></tr>
<tr><td>Laboratory based practical</td><td>10</td></tr>
<tr><td>Non-laboratory</td><td>40</td></tr>
<tr><td rowspan="8">Assessment</td><td></td><td>Percentage</td></tr>
<tr><td>Test(s)/Quizzes</td><td></td></tr>
<tr><td>Final Test</td><td></td></tr>
<tr><td>Assignment(s)</td><td></td></tr>
<tr><td>Project(s)</td><td></td></tr>
<tr><td>Seminars/Presentations</td><td>10</td></tr>
<tr><td>Report(s)</td><td>90</td></tr>
<tr><td>Total</td><td>100</td></tr>
<tr><td>Resources</td><td colspan="2">1. Murray, R., [2002]. How to write a thesis. Open University Press. Mc Graw Hill House: England.

2. Various journals in the library.

3. Inter-library loan facilities</td></tr>
</table>

Course Code	**KNC 4324**
Course Title	**Final Year Project II**
Course Credit	4 hrs
Type of Course	Core
Requisites	KNC 4312 Final Year Project I
Instructor	
Course Synopsis	Each student develops the project for which an interim report has already been produced. The individual project may be internally generated or preferably with an industrial collaboration, that may require for example: Literature search, equipment design/ modification/build/test, experimental design and validation, data collection and analysis, group collaboration on design/ analysis/ results, assessment of success/further work/ conclusions, use of industrial research/development facilities. Documentation and report write up. Presentation.
Course Aims	To carry out experiments or computer work to solve the problems identified and according to the research methodology outlined in Final Year Project I. Subsequently, to anlalyze results obtained, make conclusion, conduct a presentation and finally write a Final Year Project Report towards the end of the 14 week.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Participate in a close working partnership and take part in shared decision making process. • Demonstrate intellectual and creative ability in solving engineering problems. • To validate the data and findings from the experts, surveys and sampling as well as journals and other literature. • To discuss, debate and judge technical arguments during the presentation. • Prepare a final year report according to the standard required by the Department and Faculty in 14 week.

Learning Units	**LU 1: Initial report** - based on Project Part I. Relevant information such as the objectives and project plan must be fully finalized. **LU 2: Dissertation/Thesis** - The full project should be reported in the dissertation/thesis. There should be a description of the complete project, details of experimental techniques or research methodologies employed during the execution of the project. Data analysis and interpretation of the result obtained should be included and clearly presented. In addition, it should also include conclusions from the work and suggestions for further work. **LU 3: Presentation** - At the end of the semester, the students is expected to present his/her project findings and answers on the contents from members of staff.

Teaching - Learning Approach		**Hours per semester**
	Lectures	
	Tutorials	
	Seminars	6
	Laboratory based practical	84
	Non-laboratory	84

Assessment		**Percentage**
	Test(s)/Quizzes	
	Final Test	
	Assignment(s)	
	Project(s)	
	Seminars/Presentations	10
	Report(s)	90
	Total	100

Resources	
	1. Murray, R., [2002]. How to write a thesis. Open University Press. Mc Graw Hill House: England. 2. Various journals in the library. 3. Inter-library loan facilities.

Course Code	**KNC 4332**
Course Title	**Energy and Environmental Management**
Course Credit	2 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	The course covers the linkage of energy and environmental issues. It covers the impact of energy supply and end-use on human well being and the ecosystem is covered. It also includes a comprehensive approach to the resolution of resources, technical, economic, strategic, environmental and also socio and political problems of the energy industries.
Course Aims	To build the understanding of students on the interrelationship of energy and environment, and the importance of addressing sustainability issues to this relationships.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Describe the impacts impose to the environment due to energy industries activities. • Economics, regulations and standards associated to energy and environmental issues in energy industry. • Establish the strategies towards ecosystems conservations • Establish pathways to a sustainable energy
Learning Units	**LU 1: Review on Energy** – Current State of Energy Generation, Distribution and Usage, Definition of Fundamental Energy Terms and Parameters. **LU 2: Energy Management** – Code and Standards, Energy

<table>
<tr><td></td><td colspan="2">Economics and Accounting, Strategies for Improving Efficiency.

LU 3: Energy Generation Management – Technologies and Systems, Major Process Equipment and Building Systems, Public and Private Utilities, Power Distribution Systems, Energy Consumers Consumption, Electrical System Optimization, Waste Heat Recovery, Control System, Thermal Storage.

LU 4: Environmental Management – Environmental issues, Regulations and Standards, Environmental Impact Assessment, ISO 14001, Emergency Preparedness Planning</td></tr>
<tr><td rowspan="6">Teaching-learning Approach</td><td></td><td>Hours per semester</td></tr>
<tr><td>Lectures</td><td>28</td></tr>
<tr><td>Tutorials</td><td></td></tr>
<tr><td>Seminars</td><td></td></tr>
<tr><td>Laboratory based Practical</td><td></td></tr>
<tr><td>Non-laboratory</td><td></td></tr>
<tr><td rowspan="8">Assessment</td><td></td><td>Percentage</td></tr>
<tr><td>Test(s)/Quizzes</td><td>20</td></tr>
<tr><td>Final Test</td><td>30</td></tr>
<tr><td>Assignment(s)</td><td>20</td></tr>
<tr><td>Project(s)</td><td></td></tr>
<tr><td>Seminars/Presentations</td><td>15</td></tr>
<tr><td>Report(s)</td><td>15</td></tr>
<tr><td>Total</td><td>100</td></tr>
<tr><td>Resources</td><td colspan="2">1. Turner, W. C., [2004], Energy Management Handbook, 5th edition, CRC Press.

2. Thumann, P. E. and Younger, W. J., [2003], Handbook of Energy Audits, 6th edition, Dekker.

3. Wells, J., [2002], Solutions for Energy Security and Facility Management Challenges: WEEC Proceedings., Dekker

4. Beggs, C., [2002] Energy Management and Conservation, Butterworth-Heinemann.

5. Lilburn, G. A., [1992] Power Generation, Energy Management and Environmental Sourcebook, Fairmont Press (1992).</td></tr>
</table>

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Course Code	**KNC 4343**
Course Title	**Biodiesel and Fuel Cell for Transportation**
Course Credit	3 hrs
Type of Course	Elective
Requisites	None
Instructor	
Course Synopsis	Investigation of the technology and potential uses of Biodiesel especially for the transport application world-wide. Emphasize on various potential oil derivatives include palm-oil derivatives, peanut oils and other vegetables oils. This course also discusses on the mutual development between the emerging biodiesel productions methods to that of the applied engine technology, fuel consumption and emission control.
Course Aims	The aim of this course is to provide knowledge on the technology and potential uses of biodiesel and fuel cell technology especially for the transport application. The course also discuss on the mutual development between the emerging biodiesel productions methods and fuel cell technology to that of the internal combustion (IC) engine technology, fuel consumption and emission control.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Describe on the conventional fuel technology for automobile applications. • Discuss on the biodiesel and fuel cell technology for automobile applications. • Estimate and compare environmental impact for sustainability of various fuel technologies. • Develop or construct a simple fuel system prototype and thus evaluate the associated efficiency. • Prepare for future challenges of application of biodiesel and fuel cell in transportation.

Learning Units	**LU 1: Conventional Internal Combustion (IC) engine: Petrol and Diesel engines** -Power, torque, energy consumption and fuel combustion emissions. **LU 2: Fossil Fuels versus renewable Fuels** – Fossil fuel and emission problems. Emission guidelines. Environmental and Sustainability concern. Type of renewable fuels and their characteristics. **LU 3: Fuels and their characteristics** -Chemical and physical properties. Standard Properties determination methods. Using fuel catalyst for emissions reduction. **LU 4: Biodiesel Fuel** -How to make Biodiesel. Type of biodiesel fuel. Processing methods and cost implication. Future biodiesel fuel. Standard testing methods: Malaysian Standard. EU Standard. American Standard. **LU 5: Potential biodiesel oil derivatives** - Palm-oil derivatives, peanut oils and other vegetables oils. Physical and chemical properties and efficiency. **LU 6: Fuel cells** - How the fuel cell works? Type of fuel cells. Fuel cell Efficiency and operational voltage. **LU 7: Proton exchanged membrane (PEM) fuel cell** – Electrode and structure. Water management in fuel cell, cooling and air supply. Operating pressure. Reactant composition. Fueling fuel cells. Delivering fuel cell power. **LU 8: The clean fuels outlook.**-Overview of various findings obtained worldwide.	
Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	24
	Seminars	4
	Laboratory based practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	30
	Assignment(s)	15

	Project(s) / Case Study(s)	20
	Seminars/Presentations	5
	Report(s)	10
	Total	100
Resources	1. Martin, P., [2006], *Biodiesel for the small producer*, Chelsea Green Publishing 2. Pahl, G., [2005], *Biodiesel: Growing A New Energy Economy* ,Chelsea Green Publishing Company. 3. Pahl, G., [2004], *Biodiesel :Growing a New Energy* Economy, Chelsea Green Publishing 4. Larmine, J., and Dicks, A., [2001], *Fuel cell systems explanined*, Wiley. 5. International Energy Agency Implementing Agreement on Advance, [1999], *Automotive Fuels for the Future*, Organisation for economic Co-operation and Development. 6. Koordesch, K., and Simader, G., [1996], *Fuel Cells and Their Applications*, VCH Publication.	

Course Code	**KNC 4353**
Course Title	**Bio-energy**
Course Credit	3 hrs
Type of Course	Elective
Requisites	None
Instructor	
Course Synopsis	Introduction to bio-energy, Biomass resource formation. Thermochemical conversion. Biological conversion. Chemical conversion. Waste conversion. Power generation.
Course Aims	The aim of this course is to introduce the fundamental of bio-energy process, conversion and power generation. It enhances the student to comprehend with the future needs and development prospect of bio-energy.
Learning Outcomes	Upon the successful completion of the course, students should be able to: • Describe the fundamental knowledge of Bio-energy and production. • Categorize various conversion methods. • Compare various conversion methods and examine their efficiency. • Explain the power generation method associate with bio-energy.
Learning Units	**LU 1: Biomass resource formation** - Biomass resource, Classification and characteristics; Energy and the biosphere. Biomass and the earth's energy cycle. Techniques for biomass assessment. **LU 2: Thermochemical Conversion** - Direct combustion, incineration, pyrolysis, gasification and liquefaction.

	LU 3: Biological Conversion Biodegradation and biodegradability of substrate; Biochemistry and process parameters of biomethanation; Biogas digester types; Digester design and biogas utilisation; Chemical kinetics and mathematical modeling of biomethanation process; Economics of biogas plant with their environmental and social impacts; Bioconversion of substrates into alcohol: Methanol & ethanol Production, organic acids, solvents, amino acids, antibiotics etc. **LU 4: Chemical Conversion Hydrolysis** & hydrogenation; Solvent extraction of hydrocarbons; Solvolysis of wood; Biocrude and biodiesel; Chemicals from biomass. **LU 5: Waste Conversion** - Anaerobic digestion of sewage and municipal wastes; Direct combustion of MSW-refuse derived solid fuel; Land fill gas generation and utilization. **LU 6: Power generation** - Utilisation of gasifier for electricity generation; Operation of spark ignition and compression ignition engine with wood gas, methanol, ethanol & biogas; Biomass integrated gasification/combined cycles systems. Sustainable cofiring of biomass with coal. Biomass productivity: Energy plantation and power programme.

Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	24
	Seminars	4
	Laboratory based practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	30
	Assignment(s)	15
	Project(s) / Case Study(s)	20
	Seminars/Presentations	5
	Report(s)	10
	Total	100

Resources	1. Rosillo-Calle, Hemstock, S., de Groot, P., Woods, J., [2006], *The Biomass Assessment Handbook: Bioenergy for a Sustainable Environment*, Earthscan Publications Ltd 2. Brenes, M. D., [2006], *Biomass and Bioenergy: New Research*, Nova Science Publishers Inc. 3. Westermann, P., Haberbauer, P., and lens, M., [2006], *Biofuels for Fuel Cells: Biomass Fermentation Towards Usage in Fuel*, IWA Publishing 4. Klass, D. L. [1998], *Biomass for Renewable Energy, Fuels and Chemicals*, Academic Press Inc. 5. Blazej, Anton, [1993], *Phytomass : a raw material for chemistry and biotechnology* . New York : Ellis Horwood Limited 6. J.N. Saddler.,[1993], *Bioconversion of forest and agricultural plant residues*, London : Elsevier 7. Roger M., Tor P. Schultz, Ramani Narayan Rowell, [1992], *Emerging technologies for materials and chemicals from biomass.*, Washington, DC : American Chemical Society 8. Osamu Kitani, Carl W., Klaus Wagener, [1989], *Hall Biomass handbook*, New York : Gordon and Breach Science Publishers 9. Moo-Young, Murray, Hasnain, Sadiq., Lamptey, Jonathan., [1986], *Biotechnology and renewable,* London : Elsevier Applied Science Publishers, 10. Nicholas P. Cheremisinoff, Paul N. Cheremisinoff, Fried Ellerbusch, [1980], *Biomass: Applications, Technology, and Production*. Marcel Dekker, Inc. New York and Basel. 11. Anthony San Pietro, *Biochemical and Photosynthetic aspects of Energy Production*, Academic Press, New York, 1980.

Course Code	**KNC 4363**
Course Title	**Water and Wastewater Treatment Engineering**
Course Credit	3 hrs
Type of Course	Elective
Requisites	None
Instructor	
Course Synopsis	The course covers both characterization of water and wastewater. It then introduces various treatments processes available for water and wastewater. It also covers calculation methods in the water and wastewater treatment process. Lastly, it exposes the students to issues pertaining to management problems in handling water and wastewater.
Course Aims	Aim of this course it to review the purpose and stages in water and wastewater engineering; the water and wastewater quality standard. It also provides understanding of the conception and construction of treatment facilities and needed infrastructure as well as the challenges faced in water and wastewater engineering.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Demonstrate awareness on the water and wastewater quality assurance. • Demonstrate skills and knowledge on the treatment processes and facilities available. • Demonstrate awareness on future challenges with regards to water and wastewater engineering. • Determine suitable water and wastewater treatment process suitable for a given industrial problem.

Learning Units	**LU 1: Introduction** – Environment Engineering, Environmental Chemistry and Biology, Environmental Quality Modeling, Water Treatment, Wastewater Treatment, Water and Wastewater Operators and their Roles, Key term used in waterworks and wastewater operations. **LU 2: Characterisation of Water Chemistry** – Water Chemistry: Water Chemistry Fundamentals, Water Molecules, Water Solutions, Water Constituents, pH, Alkalinity, Hardness. **LU 3: Characterisation of Water Biology** – Water Microbiology: Microbiology, Water and Wastewater Microorganism, Bacteria, Protozoa, Microscopic Crustaceans, Viruses, Algae, Fungi, Worms. **LU 4: Water Quality** – Water Quality Standard, Water Quality Characterisation, Biological Characteristics. **LU 5: Water Treatment Operations** – Purpose of Water Treatment, Stages of Water Treatment, Pre-treatment Processes. **LU 6: Wastewater Treatment** – Wastewater Treatment Process Model, Wastewater Terminology Definitions, Wastewater Sources and Characteristics, Preliminary Treatment, Primary Treatment, Secondary Treatment, Advanced Wastewater Treatment. **LU 7: Water Treatment Process Calculations** – Water Source Calculations, Water Storage Calculations, Coagulation, Mixing and Flocculation General Calculations, Sedimentation Calculations, Water Filtration Calculations, Chlorination Calculations. **LU 8: Wastewater Treatment Process Calculations** – Preliminary Treatment Calculations, Primary Treatment Calculations, Trickling Filter Calculations, Rotating Biological Contactors Calculations, Activated Biosolid Calculations, Detention Times, Treatment Ponds. **LU 9: Management Problems Facing Water and Wastewater Operations** – Compliance with new, changing and existing regulations, Maintaining Infrastructure, Privatising, Reengineering, Benchmarking, Security, Technical Management vs. Professional Management

Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	24
	Seminars	4
	Laboratory based practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	30
	Assignment(s)	15
	Project(s)	20
	Seminars/Presentations	5
	Report(s)	10
	Total	100

Resources

1. Russell, D. L., [2006], *Practical Wastewater Treatment*, John Wiley & Sons Inc
2. Spellman, F. R. & Whiting, N. E. [2005], *Environmental Engineer's Mathematics Handbook*, CRC Press LLC, U. S. A.
3. Spellman, F. R. [2003], *Handbook of Water and Wastewater Treatment Plant Operations*, Lewis Publishers, U. S. A.
4. Tchobanoglous, Burton, F., stense, H. D., [2003], *Wastewater Engineering 4th Edition*, McGraw-Hill
5. Droste, R. L. [1997], *Theory and Practice of Water and Wastewater Treatment*, John Wiley & Sons Inc., U. S. A.
6. Sincero, A. P. & Sincero, G. A. [1996], *Environmental Engineering A Design Approach*, Prentice Hall, U. S. A.

Course Code	**KNC 4373**
Course Title	**Natural Gas Engineering**
Course Credit	3 hrs
Type of Course	Elective
Requisites	None
Instructor	
Course Synopsis	Types of Natural Gas Accumulations, Properties of Natural Gas and Condensate Systems, Separation and Processing, Compression of Natural Gas, Natural Gas Measurement, Gas Gathering and Transportation. Fundamentals of natural gas refrigeration and liquefaction, LNG and LPG processing systems, and storage of liquefied gases, LNG regasification.
Course Aims	The aim of this course is to create a deeper and wider students' knowledge in chemical engineering processes especially those relating to natural gas industry. Emphasis is put on the natural gas processing and transporting particularly Liquefied Natural Gas (LNG). This course together with other chemical engineering courses will equip the students with the practical knowledge prior to their involvement in natural gas industry.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Recognize the types of natural gas and its properties. • Relate various processes to natural gas processing and transporting. • Appraise suitable equipments for natural gas compression and measurement. • Arrange suitable processes for natural gas processing according it properties. • Manage the transportation of natural gas especially LNG.

Learning Units	**LU 1: Introductions** – Development of Natural Gas, Types of Natural Gas Accumulations. **LU 2: Properties of natural Gases and Condensate systems** - Composition, Phase Behavior, Ideal Gas principals, Properties of Gas mixtures, Behavior of Real Gases, Compressibility, Viscosity, Water vapor content, Two Phase system. **LU 3: Separation and Processing** – Gas Liquid separations, dehydration of Natural Gas, desulphurization, carbon dioxide and light hydrocarbon removal, natural gas specification. **LU 4: Compression and measurement of Natural Gas** – Types of Compressors, reciprocating Compressor, Centrifugal compressors, Rotary Blower, Methods of Measurement, Orifice Meter, Natural Gas Liquid Measurement. **LU 5: Gas Gathering and Transportations** – Reynolds number and Friction factor, pipeline flow calculation, gas flow in parallel, Series and looped pipelines, gas Liquid flow in pipelines. **LU 6: Natural gas refrigeration and liquefaction** – fundamentals of natural gas refrigeration and liquefaction. **LU 7: LNG and LPG** - processing systems, storage of liquefied gases, regasification.

Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	24
	Seminars	4
	Laboratory based practical	
	Non-laboratory	

Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	30
	Assignment(s)	15
	Project(s) / Case Study(s)	20
	Seminars/Presentations	5
	Report(s)	10
	Total	100

Resources	1. Mokhatab, S., Poe, W. A., Speight, J. G., [2006], *Handbook of Natural Gas Transmission and Processing*, Gulf Publishing 2. Kidnay, A. J., Parrish, W. R., [2006], *Fundamentals of Natural Gas Processing*, CRC Press 3. Guo, B., and Ghalambor, A., [2005], *Natural Gas Engineering Handbook*, Gulf Publishing Company 4. Ikoku, C.U., [1992], *Natural Gas Production Engineering*, Krieger Publishing Company, Malabar, Florida 5. Katz, D.L., & Lee, R.L, [1990], *Natural Gas Engineering Production and Storage*, McGraw Hill, New York

Course Code	**KNC 4383**
Course Title	**Sustainability in Energy Industry**
Course Credit	3 hrs
Type of Course	Elective
Requisites	None
Instructor	
Course Synopsis	Global and national energy supply and use, Sustainability and equity, Sustainable energy sources, Alternative fuels and feedstock, Constraints on expansion of supply, Global, regional and national initiatives tackling energy sustainability, Sustainability in power generation plants, Energy farming, sustainability assessment and tools for energy industry.
Course Aims	This course aims to elaborate and broaden the students' knowledge on the issues pertaining to energy use and generation, and systems of energy supply, principally in context of sustainability issues: social, environmental and economics. The course will initially introduce the current pattern of energy usage and issues of energy sustainability both nationally and globally and then the concepts addressing sustainability issues such as energy efficiency, carbon-free and carbon neutral programme. Toward the end of this course the mechanisms in making decision involving sustainability issues is also presented.

Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Appraise in depth on sustainability issues in chemical engineering and energy industry. • Assess key impacts of various energy sources supply, generation and usage on the environment. • Utilise various decision making methods in deciding the energy project which addresses sustainability issues the best. • Develop critical thinking and independent study related to energy sustainability.
Learning Units	**LU 1: Global and national energy supply** - sources and resources. **LU 2: Global and national energy use**- distribution, growth, patterns of demand. **LU 3: Sustainability and equity** – Earth summit, Kyoto Protocol **LU 4: Sustainable energy sources** - renewable, carbon-free, carbon-neutral. **LU 5: Alternative fuels and feedstock** - hydrogen, methanol, biodiesel, biogas, agricultural waste, municipal solid waste. **LU 6: Constraints on expansion of supply** - economic, environmental cost, social cost, technological capability and institutional factors. **LU 7: Global, regional and national initiatives tackling energy sustainability** - Clean Development Mechanism, Clean technology. **LU 8: Sustainability in power generation plants** - Fossil fuels – diesel, natural gas and coal, biomass – direct combustion, gasification, pyrolysis and fermentation, Fuel cell – hydrogen, methanol, biogas, Solar, wind, hydroelectric. **LU 9: Energy farming** – agricultural waste, silviculture energy plantation. **LU 10: Various sustainability assessment and tools for energy industry** - Qualitative and quantitative multi-criteria assessment, Cost-benefit analysis.

Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	24
	Seminars	4
	Laboratory based practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	30
	Assignment(s)	15
	Project(s) / Case Study(s)	20
	Seminars/Presentations	5
	Report(s)	10
	Total	100
Resources	1. Rosillo-Calle, F., Hemstock, S., de Groot, P. and Woods, J. [2006], *The Biomass Assessment Handbook: Bioenergy for a Sustainable Environment*, Earthscan Publications 2. Jaccard, M., [2005], *Sustainable Fossil Fuels: The Unusual suspect in the Quest for Clean and Enduring energy*, Cambridge University Press, Cambridge, UK 3. Open University [2004], *Energy for a Sustainable Future: Managing Energy Demand and Sustainable Energy Futures*, Open University 4. Boyle, G., Everett, B., and Ramage, J., [2003], *Energy Systems and Sustainability : Power for A Sustainable Future*, Oxford University Press, Oxford, UK	

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Course Code	**KNF 1013**
Course Title	**Engineering Mathematics 1**
Course Credit	3 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	Fundamental concepts of Functions, Limits, Differentiation, Integration, Series, Logarithmic, exponential, power and hyperbolic functions. Complex numbers, Multivariable Calculus.
Course Aims	The aim of the course is to provide the student with sufficient mathematical principles and fundamentals in engineering mathematics especially calculus.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Define calculus equations and explain their solving methods • Use calculus as a mathematical tool for formulating equations governing the physical chemical processes or other engineering problems. • Solve mathematically calculus problems in engineering science.
Learning Units	**LU 1: Functions** - Real functions of one variable. Domain and range. One-one function. Inverse of a function. Some elementary functions-polynomical, rational, trigonometrical and inverse trigonometrical functions. **LU 2: Limits** - Limit of a function. First order derivatives. Differentiation of some elementary functions. **LU 3: Differentiation** - Differentiability and continuity. Tangent

	and normal. Increasing and decreasing functions. Concavity. Local maximum and minimum. Extremes of functions. **LU 4: Taylor-Maclaurin Polynomials and Series** - Polynomial approximations. Basic concepts of series. Taylor Maclaurin series. L'Hopital rule. Newton-Raphson method. **LU 5: Integration** - Definite integrals. Leibitz's. Evaluation of definite integrals. Integration by parts. Integration by partial fractions. Numerical integration. **LU 6: Logarithmic, exponential, power and hyperbolic functions.** **LU 7: Introduction To Complex Numbers** **LU 8: Multivariable Calculus** - Real functions of several variables. Domain and range. Contour. Surfaces. Limit and continuity. Partial differentiation. Chain rule. Double and triple integrals. Cartesian, polar, cylindrical and spherical coordinates. Applications.

Teaching - Learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	28
	Seminars	
	Laboratory based practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	30
	Final Test	50
	Assignment(s)	20
	Project(s)	
	Seminars/Presentations	
	Report(s)	
	Total	100

Resources	1. Kreyszig, E., [2005], Advanced Engineering Mathematics 9th edition, John Wiley and Sons 2. Bird, J. O., [2005], Basic Engineering Mathematics 4th edition, Butterworth-Heinemann Ltd 3. Stroud, K. A and Booth, D. J., [2003], Advanced Engineering Mathematics 4th ed, Palgrave Macmillan 4. Croft, T., and Davison, R., [2003], Mathematics for Engineers: A Modern Interactive Approach, Prentice Hall 5. Stroud, K. A and Booth, D. J., [2001], Engineering Mathematics 5th ed, Palgrave Macmillan

Course Code	**KNF 1023**
Course Title	**Engineering Mathematics II**
Type of Course	Core
Requisites	KNF 1013 Engineering Mathematics I
Instructor	
Course Synopsis	Ordinary differential equations, Laplace transformation Fourier series, partial differential equations
Course Aims	The aim of the course is to provide the student with sufficient understanding of mathematical principles and fundamentals in engineering mathematics
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Analyze differential equations, with an emphasis on its application in engineering science. • Describe the method of Laplace transformation, Fourier series and their applications in mathematics. • Explain and analyse partial differential equations and their simple application in solving engineering problems.

Learning Units	**LU 1: Solving Ordinary Differential Equations** -Introduction to ordinary differential equations (ODEs), basic concepts. -1st order ODEs, separable form. -Applications in growth and decay, ODEs reducible to separable form. -1st order linear ODEs, ODEs in exact form. -2nd order linear ODEs, general theory, ODEs with constant coefficients, Euler-Cauchy ODEs. -2nd order inhomogeneous ODEs, solving by guesswork and method of variation of parameters. -Introduction to Microsoft Excel spreadsheet, Euler's method for 1st order ODEs. -Numerical method for 2nd order ODEs. **LU 2: Applications** -Flow of current in a circuit. -Spring-mass system. **LU 3: Laplace Transforms and Ordinary Differential Equation** -Introduction to Laplace transforms. -Laplace transforms of some elementary functions, applications to ODEs. -Properties of Laplace transforms, solving ODEs. **LU 4: Fourier Series and Partial Differential Equations** -Theory of Fourier series. -Partial differential equation (PDE) for a vibrating string, initial boundary value problem, solution by Fourier series.	
Teaching-learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	28
	Seminars	-
	Laboratory based Practical	-
	Non-laboratory	-
Assessment		**Percentage**
	Test(s)/Quizzes	30
	Final Test	50
	Assignment(s)	10
	Project(s)	10
	Seminars/Presentations	
	Report(s)	
	Total	100

Resources	1. Kreyszig, E., [2005], Advanced Engineering Mathematics 9th edition, John Wiley and Sons 2. Bird, J. O., [2005], Basic Engineering Mathematics 4th edition, Butterworth-Heinemann Ltd 3. Stroud, K. A and Booth, D. J., [2003], Advanced Engineering Mathematics 4th ed, Palgrave Macmillan 4. Croft, T., and Davison, R., [2003], Mathematics for Engineers: A Modern Interactive Approach, Prentice Hall 5. Stroud, K. A and Booth, D. J., [2001], Engineering Mathematics 5th ed, Palgrave Macmillan

Course Code	**KNF 1082**
Course Title	**Engineering Programming**
Course Credit	2 hrs
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	The course introduces two main themes: Algorithms and algorithmic problem solving and also the Fundamental problem-solving paradigms-procedural i.e. FORTRAN
Course Aims	The aim of the introductory course is to lay a foundation for further studies in science and engineering by giving students a broad overview of the discipline.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Use Fortran as the programming language. • Formulate the algorithm in Fortran for the problem. • Apply the programming skills into other subjects to be taken.
Learning Units	**LU 1:** Introduction to Programming **LU 2:** Algorithm **LU 3:** Flow Charting **LU 4:** Introduction to Fortran **LU 5:** Variables and Constants **LU 6:** Expressions, assignments & intrinsic functions

	LU 7: Subprograms and initialized variables **LU 8:** Selection, logical data types **LU 9:** Repetition & file processing **LU 10:** Arrays **LU 11:**Strings **LU 12:** Structure **LU 13:** Modules **LU 14:** I/O files

Teaching - Learning Approach		**Hours per semester**
	Lectures	14
	Tutorials	
	Seminars	
	Laboratory based practical	14
	Non-laboratory	

Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	30
	Assignment(s)	20
	Project(s)	30
	Seminars/Presentations	
	Report(s)	
	Total	100

Resources

1. Sleightholme, C, and Sleightholme J., [2005] *Introduction to Programming with Fortran: With Coverage of FORTRAN 90, 95, 2003 and 77*, Springer-Verlag London Ltd
2. Chapman, S., [2004], *Fortran 90/95 for Scientists and Engineers*, McGraw Hill
3. Adams, J. C., Brainerd, W. S., Martin, J. T., Smith, B., and Wagener, J. L., [1997] *Fortran 95 Handbook (Scientific & Engineering Computation)*, The MIT Press

4. Nyhoff, L., and Leestma, S., [1996] *FORTRAN 90 for Engineers and Scientists*, Prentice Hall

5. Ellis, Philips and Lahey, [1992], *FORTRAN90 Programming*.

Course Code	**KNF 2033**
Course Title	**Engineering Mathematics III**
Type of Course	Core
Requisites	KNF 1013 Engineering Mathematics I KNF 1023 Engineering Mathematics II
Instructor	
Course Synopsis	Systems of linear algebraic equations, methods of solution, systems of ordinary differential equations, eigenvalue problem.
Course Aims	In the first part Linear Algebra, students are exposed to systems of linear algebraic equations (solutions and other related problems) and the matrix eigenvalue problem (e.g. in the solution of a system of ordinary differential equations). The second part Vector Calculus seeks to equip the students with some useful advanced calculus tools which enable them to deal with more realistic (three-dimensional) problems in engineering science.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Understand the system of linear algebraic equations, inverse matrix and determinant of a matrix. • Distinguish between eigenvalues and eigenvectors of a matrix. • Describe the vector fields, gradient of a scalar function and Divergence and curl of a vector function. • Explain and analyse the line integral, double integral, Green theorem, surface and volume integrals.

Learning Units	**LU 1: System of linear algebraic equations.** -Method of solution by eliminations. Consistency. Row operations. -Computer methods for solving systems of linear algebraic Equations, e.g. Gauss-Seidel iteration. -System of linear algebraic equations in matrix form. **LU 2: Inverse of a matrix.** -Elementary matrices. -Method of finding the multiplicative inverse. **LU 3: Determinant of a matrix.** -Definition, evaluation and some results for systems of linear algebraic equations. **LU 4: Eigenvalues and eigenvectors of a matrix.** -Applications to solving a system of ODEs. **LU 5: Vector fields.** -Vector functions. **LU 6: Gradient of a scalar function.** **LU 7: Divergence and curl of a vector function.** -Examples of usage in mechanics and field theory. -Curves in cuclidean space. **LU 8: Line integrals.** -Line integral expression for work done. **LU 9: Double integrals.** -Areas and centroids of two-dimensional bodies. **LU 10: Green's theorem.** -Derivation of line integral expressions for areas and centroids of two-dimensional bodies. **LU 11: Surface and volume integrals.** -Gauss theorem.

Teaching-learning Approach		**Hours per semester**
	Lectures	28
	Class Tutorials	28
	Group Tutorials	-
	Seminars	-
	Laboratory based Practical	-
	Non-laboratory	-

Assessment		**Percentage**
	Test(s)/Quizzes	30
	Final Test	50
	Assignment(s)	10
	Project(s)	10
	Seminars/Presentations	
	Report(s)	
	Total	100
Resources	1. Kreyszig, E., [2005], Advanced Engineering Mathematics 9th edition, John Wiley and Sons 2. Bird, J. O., [2005], Basic Engineering Mathematics 4th edition, Butterworth-Heinemann Ltd 3. Stroud, K. A and Booth, D. J., [2003], Advanced Engineering Mathematics 4th ed, Palgrave Macmillan 4. Croft, T., and Davison, R., [2003], Mathematics for Engineers: A Modern Interactive Approach, Prentice Hall 5. Stroud, K. A and Booth, D. J., [2001], Engineering Mathematics 5th ed, Palgrave Macmillan	

Course Code	**KNF 2053**
Course Title	**Numerical Methods And Statistics**
Type of Course	Core
Requisites	KNF 1013 Engineering Mathematics KNF 1023 Engineering Mathematics II KNF 2033 Engineering Mathematics III
Instructor	
Course Synopsis	Introduction to the principles and applications of numerical method analysis especially in linear and non-linear algebraic equation, interpolation, integration and differential equation. Second parts of the course introduce statistic application in engineering.
Course Aims	The aim of this course is to supplement the student with the knowledge of numerical analysis method for engineering computing applications and also statistic for engineering experimental aspect.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Interpret the numerical method theories. • Appraise the application of numerical method theories in engineering aspect. • Examine statistic and application of statistic application in engineering.

Learning Units	**Numerical Methods** **LU 1: Linear Algebraic Equation** – Gaussian elimination, LU factorisation, Pivoting, Ill-conditioning, Gauss-Seidel method, Gradient Method. **LU 2: Nonlinear Equations** - Iterative substitution, Multiple root, Bisection Method, Newton-Raphson method and modified Newton Raphson method. **LU 3: Interpolation and Curve Fitting** - Lagrangian polynomial, Difference method, Spline method. **LU 4: Numerical Integration** - Newton-Cotes rules, Gauss Legendre rules. **LU 5: Numerical Solution of Ordinary Differential Equation** - Euler Method, Modified Euler Method, Midpoint Method, Runge Kutta Method , Euler trapezoidal, Milne's Method, Adams-Moulton-Bashforth method **Statistics** **LU 6: Distribution** - Discrete uniform distribution, Continuous distribution. **LU 7: Descriptive Statistic** - measures of location, measures of variability. **LU 8: Statistical Inference and Estimation** - Statistical estimation, Interval estimation, Estimation of mean, estimation of a single variance. **LU 9: Hypothesis Formulation and Testing** - types of error, testing of hypotheses, two tailed and one tailed test. **LU10: Analysis of Variance** - one-way analysis of variance, two-way analysis of variance.

Teaching-learning Approach		**Hours per semester**
	Lectures	28
	Tutorials	28
	Seminars	-
	Laboratory based practical	-
	Non-laboratory	-
Assessment		**Percentage**
	Test(s)/Quizzes	30

	Final Test	50
	Assignment(s)	10
	Project(s)	10
	Seminars/Presentations	
	Report(s)	
	Total	100

Resources

1. Montgometry, D. C. and Runger, G. C., [2006], Applied Statistics and Probability for Engineers John Wiley & Sons
2. Chapra, S. C. and Canale, R. P., [2005], Numerical Methods for Engineers 5th Edition, McGraw-Hill
3. Ross, S. M., [2004], Introduction to Probability and Statistics for Engineers and Scientists, Academic Press Inc.
4. Faires, J. D. and Burden, R., [2002], Numerical Methods 3rd Edition, Brooks Cole
5. Hoffman, J., [2001], Numerical Methods for Engineers and Scientists, Dekker Ltd
6. Akai, T. J, [1993], *Applied Numerical Method for Engineers,* Wiley & Sons
7. Griffiths, D.V. and Smith, I.M. [1991], *Numerical Methods for Engineers,* Blackwell Scientific Publication.
8. Bethea, R.M and Rhinehart R. R. [1991], *Applied Engineering Statistic*, Marcel Dekker

Course Code	**KNF 3066**	
Type Title	**Industrial Training**	
Type of Course	Core	
Requisites	Completed Year 1, Year 2 and Year 3 Courses	
Instructor	All members of staff	
Course Synopsis	Students are placed in a host organization for a minimum period of 14 weeks to undergo relative training relevant to engineering aspects of works.	
Course Aims	This industrial-driven course aims to introduce students to the ethic of engineering and responsibilities of engineers in real-world situation. It exposes students to the various aspects of engineering practice and engineering skills, including that of writing technical report, communications, technical evaluations and designs. It also exposes students to various engineering job opportunities after graduation.	
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Correlate theoretical with actual industrial practice. • Understand various aspects of engineering practice. • Communicate effectively. • Develop professional skills. • Appreciate latest industrial development and requirements.	
Learning Units	To be prepared prior to students departure to respective companies/institutions.	
Teaching-learning Approach		**Hours per semester**
	Lectures	-
	Tutorials	-
	Seminars	-

	Laboratory based Practical	-
	Non-laboratory	-
Assessment	Assessment report by training supervisor at host organization.	40%
	Assessment report by visiting supervisor from Faculty of Engineering, UNIMAS	25%
	Student's log book and overall industrial training report	25%
	Seminar/Presentation by students at the university upon completion of the training	10%
Resources	Faculty of Engineering Industrial Training Guidebook	

Course Code	**KNF 3102**
Course Title	**Engineering Ethics**
Type of Course	Core
Requisites	None
Instructor	
Course Synopsis	Engineering Ethics
Course Aims	This course aims to provide the understanding of the actual ethical implications of engineering works. It also provides the awareness of the social responsibilities of engineers.
Learning Outcomes	Upon the successful completion of the course, the students shall be able to learn the issues, ethical and moral values of engineering.
Learning Units	**LU 1:** Scope and aims of engineering ethics. Why study?. **LU 2:** Engineering ethics. Moral dilemmas, the associated theories behind ethics. Professions and professionalism. **LU 3:** Code of ethics, corporation and ethical theories, moral education for engineers. **LU 4:** Engineering as social experimentation, learning from past mistakes, contrast with standard experiments, accountability. **LU 5:** Commitment to safety, safety and risk, assessment of risk, risk-benefit analyses. **LU 6:** Responsibilities to employers, collegiaty and loyalty, confidentiality, conflicts of interest, occupational crime **LU 7:** Rights of engineers, professional rights, whistle blower, case study. **LU 8:** Global Issues, multinational corporations, environmental ethics, computer ethics, weapon development. **LU 9:** Engineers as managers, consultants and leaders, moral leadership.
Teaching-learning	**Hours per semester**

Approach	Lectures	26
	Tutorials	
	Seminars	2
	Laboratory based Practical	
	Non-laboratory	
Assessment		**Percentage**
	Test(s)/Quizzes	20
	Final Test	30
	Assignment(s)	40
	Project(s) / Case Study(s)	10
	Seminars/Presentations	
	Report(s)	
	Total	100
Resources	1. Schinzinger, R., & Martin, M. W., [2000], *Introduction to Engineering Ethics*, , McGraw Hill 2. Schinzinger, R., & Martin, M. W., [1996], *Ethics in Engineering,* McGraw Hill 3. Harris, C. E., Jr., Pritchard, M. S., & Rabins, M.J., [1995], *Engineering Ethics: Concepts and Cases*, Wadsworth 4. Johnson, D. G. , [1991], *Ethical Issues in Engineering*, Prentice Hall	

Course Code	**KNF 4073**
Course Title	**Engineering Management**
Type of Course	Core
Requisites	Final Year Standing
Instructor	
Course Synopsis	Principles and techniques of management. Management functions. Economic analysis of Engineering projects. Project management. Critical path method. Linear programming. Contract administration. Engineering case studies.
Course Aims	This subject prepares students with comprehensive awareness and knowledge of how to be effective performers, as leaders in today's complex environment, as engineers, managers and educators in designing, implementing, operating and optimizing any technology related enterprises, government or industrial service sectors.
Learning Outcomes	Upon the successful completion of the course, the students should be able to: • Have a sound understanding of the principles and techniques of engineering management. • Describe and analyze excellent technical and managerial skills for effective engineering management. • Appreciate good and prudent management. • Identify and determine how organization work and analyze probable outcomes. • Describe and analyze good leadership and associated characteristics associated with a good leader.

Learning Units	**LU 1: Introduction to Engineering And Management** -Introduction to management functions of planning, organizing, motivating and controlling. -Engineering Management: A Synthesis **LU 2: Historical Development of Engineering Management** -The Industrial Revolution -Scientific Management -Administrative Management -Behavioral Theories: -The Hawthorne Studies **LU 3: Aspects of Organization** -Staffing Technical Organizations -Authority and Power -Delegation -Committees and Meeting **LU 4: Controlling** -The Process of Control -Financial Controls -No financial Controls **LU 5: Managing Engineering Design** -Nature of Engineering Design -Systems Engineering/New Product Development -Concurrent Engineering and CALS -Control Systems in Design -Product Liability and Safety -Designing for Reliability **LU 6: Engineering Project Planning and Acquisition** -Characteristics of a Project -The Project Proposal Process -Project Planning Tools -Types of Contracts **LU 7: Project Organization, Leadership and Control** -Project Organization -The Project Manager -Motivating Project Performance -Controlling Cost and Schedule

<table>
<tr><td></td><td colspan="2">LU 8: Managing Engineering Career
-Getting off to the Right Start
-Charting Your Career
-Communicating Your Ideas
-Staying Technically Competent
-Professional Activity
-Management and the Engineer
-International Management
-Managing Your Time
-Professional Ethics and conduct
-Future Considerations in Engineering and Management</td></tr>
<tr><td rowspan="6">Teaching-learning Approach</td><td></td><td>Hours per semester</td></tr>
<tr><td>Lectures</td><td>35</td></tr>
<tr><td>Tutorials</td><td>14</td></tr>
<tr><td>Seminars</td><td>-</td></tr>
<tr><td>Laboratory based Practical</td><td>-</td></tr>
<tr><td>Non-laboratory</td><td>-</td></tr>
<tr><td rowspan="8">Assessment</td><td></td><td>Percentage</td></tr>
<tr><td>Test(s)/Quizzes</td><td>20</td></tr>
<tr><td>Final Test</td><td>30</td></tr>
<tr><td>Assignment(s)</td><td>20</td></tr>
<tr><td>Project(s)</td><td>30</td></tr>
<tr><td>Seminars/Presentations</td><td></td></tr>
<tr><td>Report(s)</td><td></td></tr>
<tr><td>Total</td><td>100</td></tr>
<tr><td>Resources</td><td colspan="2">1. Nicholas, J. M, [2004], Project Management for Business and Engineering, Second Edition: Principles and Practice, Heinemann.

2. Chang, C. M., [2004], Engineering Management: Challenges in the New Millennium, Prentice Hall

3. Blanchard, B. S., [2003], System Engineering Management Wiley

4. Project Management: A Managerial Approach, Fourth Edition, Jack R. Meredith and Samuel J. Mantel by John Wiley and Sons, 1995

5. Johnson, D.W., Johnson, F.P., Joining Together: Group Theory and Group Skills, 5th ed., Bacon, Boston, 1994.</td></tr>
</table>

6. Frederick Betz, *Strategic Technology Management*, McGraw-Hill, 1993

7. Hudson, *Maynard's Industrial Engineering Handbook*, McGraw-Hill, 1990

- End of Syllabus -

Lampiran I

Lembaga Penasihat

Lampiran I
Lembaga Penasihat

Penasihat Nasional	:	1. Professor Dr. Kamarul Asri Timbalan Dekan (Akademik) Jabatan Kejuruteraan Kimia Universiti Teknologi Malaysia
		2. Professor Madya Dr. Ezzat Chan Abdullah Ketua Jabatan Kejuruteraan Kimia Universiti Malaya
Penasihat International	:	3. Akan ditentukan kemudian
Penasihat Industri	:	4. Akan ditentukan kemudian
Penasihat IEM	:	5. Akan ditentukan kemudian

Lampiran J

Hubungkait Silibus Dengan Industri-industri SCORE di Sarawak

Lampiran J
HUBUNGKAIT SILIBUS DENGAN INDUSTRI-INDUSTRI SCORE DI SARAWAK

Lampiran ini menjelaskan hubungkait antara subjek-subjek yang ditawarkan dalam program kejuruteraan kimia, UNIMAS dengan perkembangan industri utama di Sarawak seperti industri tenaga, industri minyak dan gas dan industri pemprosesan yang lain. Penawaran program ini yang bermatlamat untuk menghasilkan graduan berilmu dan berkemahiran tinggi adalah bertepatan dengan perkembangan ekonomi Sarawak dan Malaysia secara keseluruhannya. Ini memandangkan Sarawak kaya dengan sumber-sumber seperti arang batu, simpanan hidrokarbon, perkayuan, kelapa sawit, dan lain-lain. Pengkhususan sustanabiliti tenaga yang digabungkan dengan kejuruteraan kimia adalah selari dengan pelancaran 'Sarawak Corridor of Renewable Energy' (SCORE) yang telah dilancarkan pada 11 Februari 2008 oleh kerajaan Sarawak yang akan beroperasi di sepanjang Similajau ke Tanjung Manis. Salah satu objektif SCORE ialah untuk meningkatkan perkembangan ekonomi dengan memajukan sektor perindustrian berasaskan bahan-bahan mentah yang sedia ada di Sarawak. Pelancaran SCORE akan membuka banyak peluang-peluang pekerjaan mahir termasuk jurutera kimia, dan ini bermakna lebih ramai lagi graduan kejuruteraan mahir diperlukan untuk merealisasikan matlamat SCORE; Seramai 4,700 pekerja mahir dan 4,060 graduan jurutera diperlukan setiap tahun mengikut jangkaan unit perancangan Sarawak 2008. Program Kejuruteraan Kimia, UNIMAS dijangka menghasilkan graduan seramai 30 jurutera kimia pada akhir sesi pengajian 2012/2013, dan jumlah ini dijangka akan meningkat kepada 80-100 graduan setiap tahun (sila rujuk mukasurat 20).

Silibus (Jadual 1A, mukasurat 14 – 17) yang terkandung dalam program ini dijangka boleh menyediakan graduan yang bukan sahaja mempunyai ilmu mantap asas dalam kejuruteraan kimia tetapi juga ilmu asas berkenaan dengan industri tenaga bagi memenuhi pasaran pekerjaan di Malaysia dan Sarawak khususnya. Pengkhususan sustanabiliti tenaga yang ditawarkan menjadikan program ini berbeza dengan program-program kejuruteraan kimia yang ditawarkan di institusi-institusi pengajian lain di Malaysia (sila rujuk Jadual G4 di mukasurat 57). Kursus-kursus yang ditawarkan (Jadual 1A, mukasurat 14 – 17) dijangka akan melengkapkan graduan dengan ilmu kejuruteraan yang berkaitan dengan keperluan industri di Sarawak seperti yang diringkaskan dalam Jadual J-1. Contohnya, industri berasaskan minyak (oil-based industry) yang melibatkan pemprosesan bahan galian mentah kepada hasilan yang boleh digunapakai, memerlukan jurutera yang mempunyai pengetahuan dalam pengendalian loji. Maka kursus-kursus seperti mekanik bendalir, keseimbangan bahan dan haba, termodinamik, unit operasi kimia, system kawalan proses dan sebagainya seperti yang diringkaskan dalam Jadual J-1 perlu dipelajari oleh graduan kejuruteraan kimia.

Di samping itu, beberapa kursus penting lain (yang tidak dimasukkan dalam Jadual J-1) yang berkaitan dengan kejuruteraan turut ditawarkan seperti keselamatan kejuruteraan, etika kejuruteraan, pengurusan kejuruteraan, lukisan kejuruteraan, matematik kejuruteraan, pemprograman kejuruteraan, ekonomi kejuruteraan, amalan bengkel, kaedah numerikal dan statistik, latihan industri dan kawalan kualiti dan keboleharapan. Kursus-kursus ini bertujuan untuk melengkapkan graduan bukan sahaja dengan ilmu kejuruteraan kimia tetapi juga dengan pelbagai aspek ilmu kejuruteraan dan bukan kejuruteraan.

Jadual J-1: Hubungkait di antara kursus-kursus yang ditawarkan oleh program Kejuruteraan Kimia, UNIMAS dengan 10 industri utama SCORE.

Jenis industri	**Kursus yang ditawarkan**			**Catatan**
1. Industri berasaskan minyak *(Oil-based industry)*	KNC1013	:	Mekanik bendalir	Program Kejuruteraan Kimia, UNIMAS dijangka dapat menyediakan graduan untuk berkecimpung dalam sektor penapisan minyak, carigali, pemprosesan gas asli dan produk berasaskan petroleum, pengurusan sisa dan alam sekitar, sustanabiliti tenaga pengurusan loji, dan penyelidikan dan pembangunan dalam bidang yang berkaitan.
	KNC1042	:	Pengenalan kepada keseimbangan bahan dan haba	
	KNC1063& KNC2133	:	Termodinamik I & II	
	KNC2122	:	Pengenalan kepada pemindahan haba dan jisim	
	KNC2142	:	Kejuruteraan alam sekitar	
	KNC2162& KNC3223	:	Unit operasi kimia I & II	
	KNC2173	:	Proses pemindahan	
	KNC2193	:	Proses pengasingan dan teknologi partikel,	
	KNC2202	:	Proses instrumentasi	
	KNC3233	:	Sistem kawalan proses	
	KNC3243	:	Proses tindakbalas kimia	
	KNC3253	:	Rekabentuk proses	
	KNC4294	:	Rekabentuk loji kimia	
	KNC4332	:	Pengurusan tenaga dan alam sekitar	
	KNC4373	:	Kejuruteraan gas asli	
	KNC4383	:	Sustanabiliti dalam industri tenaga	

Jenis industri	Kursus yang ditawarkan			Catatan
2. Industri aluminium *(Aluminium Industries)*	KNC1013	:	Mekanik bendalir	Program Kejuruteraan Kimia UNIMAS dijangka dapat menyediakan graduan untuk bekerja dalam sektor pemprosesan logam aluminium dari bijih, pengurusan sisa dan alam sekitar serta dapat mengaplikasikan sustainabiliti dalam pengurusan tenaga, dan penyelidikan dan pembangunan dalam bidang yang berkaitan.
	KNC1042	:	Pengenalan kepada keseimbangan bahan dan haba	
	KNC1063& KNC2133	:	Termodinamik I & II	
	KNC1082	:	Kejuruteraan Bahan	
	KNC2122		Pengenalan kepada pemindahan haba dan jisim	
	KNC2142	:	Kejuruteraan alam sekitar	
	KNC2173	:	Proses pemindahan	
	KNC2193	:	Proses pengasingan dan teknologi partikel	
	KNC2202	:	Proses instrumentasi	
	KNC2162& KNC3223	:	Unit operasi kimia I & II	
	KNC3233	:	Sistem kawalan proses	
	KNC3253	:	Rekabentuk proses	
	KNC3243	:	Proses tindakbalas kimia	
	KNC4294	:	Rekabentuk loji kimia	
	KNC4383	:	Sustanabiliti dalam industri tenaga	
	KNC4273	:	Sumber tenaga dan aplikasi	
3. Industri berasaskan logam termasuk keluli, nikel dan zink *(Metal-based industry including steel, nickel and zinc)*	KNC1013	:	Mekanik bendalir	Program Kejuruteraan Kimia UNIMAS dijangka dapat menyediakan graduan untuk berkecimpung dalam pemprosesan logam, pengurusan sisa dan alam sekitar, pengurusan tenaga dan penyelidikan dan pembangunan dalam bidang yang berkaitan.
	KNC1042	:	Pengenalan kepada keseimbangan bahan dan haba	
	KNC1082		Kejuruteraan bahan	
	KNC1063& KNC2133	:	Termodinamik I & II	
	KNC2122	:	Pengenalan kepada pemindahan haba dan jisim	
	KNC2142	:	Kejuruteraan alam sekitar	
	KNC2162& KNC3223	:	Unit operasi kimia I & II	
	KNC2202	:	Proses instrumentasi	
	KNC3233	:	Sistem kawalan proses	
	KNC3243	:	Proses tindakbalas kimia	
	KNC4273	:	Sumber tenaga dan aplikasi	
	KNC4294	:	Rekabentuk loji kimia	
	KNC4383	:	Sustanabiliti dalam industri tenaga	

Jenis industri	Kursus yang ditawarkan			Catatan
4. Industri kaca *Glass industry*	KNC1013 KNC1082	:	Mekanik bendalir Kejuruteraan bahan	Program Kejuruteraan Kimia UNIMAS dijangka dapat menyediakan graduan untuk berkecimpung dalam pemprosesan bahan mentah kaca, pengurusan sisa dan alam sekitar, pengurusan tenaga dan penyelidikan dan pembangunan dalam bidang yang berkaitan.
	KNC1042	:	Pengenalan kepada keseimbangan bahan dan haba	
	KNC1063& KNC2133	:	Termodinamik I & II	
	KNC2122	:	Pengenalan kepada pemindahan haba dan jisim	
	KNC2173	:	Proses pemindahan	
	KNC2193	:	Proses pengasingan dan teknologi partikel	
	KNC2202	:	Proses instrumentasi	
	KNC2142	:	Kejuruteraan alam sekitar	
	KNC3233	:	Sistem kawalan proses	
	KNC3243	:	Proses tindakbalas kimia	
	KNC4273	:	Sumber tenaga dan aplikasi	
	KNC4294	:	Rekabentuk proses	
	KNC4383	:	Sustanabiliti dalam industri tenaga	
	KNC4332	:	Pengurusan tenaga dan alam sekitar	
5. Industri kelapa sawit *Palm oil industry*	KNC1042	:	Pengenalan kepada keseimbangan bahan dan haba	Program Kejuruteraan Kimia UNIMAS dijangka dapat menyediakan graduan untuk berkecimpung dalam pemprosesan, pembuatan baja, pengurusan tenaga, biomass,
	KNC1063& KNC2133	:	Termodinamik I & II	
	KNC2122	:	Pengenalan kepada pemindahan haba dan jisim	
	KNC2142	:	Kejuruteraan alam sekitar	
	KNC2193	:	Proses pengasingan dan teknologi partikel	
	KNC2173	:	Proses pemindahan	
	KNC2193	:	Proses pengasingan dan teknologi partikel	
	KNC2202	:	Proses instrumentasi	
	KNC3233	:	Sistem kawalan proses	
	KNC3253	:	Rekabentuk proses	
	KNC4294	:	Rekabentuk loji kimia	
	KNC4343	:	*Biodiesel* dan *fuel cell* untuk pengangkutan	
	KNC4353	:	Tenaga-bio	
	KNC4273	:	Sumber tenaga dan aplikasi	
	KNC4383	:	Sustanabiliti dalam industri tenaga	

Jenis industri	Kursus yang ditawarkan	Catatan
6. Industri perkayuan *Timber-based industry including pulp and paper*	KNC1082 : Kejuruteraan bahan KNC1042 : Kesimbangan bahan dan haba KNC2142 : Kejuruteraan alam sekitar KNC1063 : Termodinamik KNC2202 : Proses instrumentasi KNC3233 : Sistem kawalan proses	Program Kejuruteraan Kimia UNIMAS dijangka dapat menyediakan graduan untuk berkecimpung dalam pemprosesan, pengurusan tenaga, biomass, pengurusan sisa, penyelidikan dan pembangunan untuk pulpa dan kertas
7. Industri perternakan *Livestock industry*	KNC2142 : Kejuruteraan alam sekitar KNC2112 : Kimia analisis KNC1052 : Kimia organik KNC2173 : Proses pemindahan KNC2193 : Proses pengasingan dan teknologi partikel KNC2202 : Proses instrumentasi KNC3233 : Sistem kawalan proses KNC3243 : Proses tindakbalas kimia KNC3253 : Rekabentuk proses KNC4383 : Sustanabiliti dalam industri tenaga KNC1082 : Kejuruteraan bahan	Program Kejuruteraan Kimia UNIMAS dijangka dapat menyediakan graduan untuk berkecimpung dalam, pengurusan tenaga, pemprosesan makanan, rawatan sisa air dan pemprosesan baja
8. Industri perikanan dan akuakultur	KNC2142 : Kejuruteraan alam sekitar KNC2112 : Kimia analisis KNC1052 : Kimia organik KNC2173 : Proses pemindahan KNC2193 : Proses pengasingan dan teknologi partikel KNC2202 : Proses instrumentasi KNC3233 : Sistem kawalan proses KNC3243 : Proses tindakbalas kimia KNC3253 : Rekabentuk proses KNC4383 : Sustanabiliti dalam industri tenaga KNC1082 : Kejuruteraan bahan	Program Kejuruteraan Kimia UNIMAS dijangka dapat menyediakan graduan untuk berkecimpung dalam pengurusan sisa, pemprosesan makanan, pemprosesan baja, pengurusan tenaga, penyelidikan dan pembangunan dalam penghasilan produk baru

Hadir

Prof. Madya Dr. Wan Hashim Wan Ibrahim	-	Dekan, Fakulti Kejuruteraan, Universiti Malaysia Sarawak (Pengerusi)
Prof. Madya Dr. Ezzat Chan Abdullah	-	Ketua Jabatan Kejuruteraan Kimia, Universiti Malaya
Prof. Madya Dr. Sharifah Aishah Syed Abdul Kadir	-	Dekan, Fakulti Kejuruteraan Kimia, Universiti Teknologi MARA
Prof. Madya Dr. Robiah Yunus	-	Ketua Jabatan Kejuruteraan Kimia, Universiti Putra Malaysia
Prof. Dr. Zainuddin Abdul Manan	-	Wakil Ketua Jabatan Kejuruteraan Kimia, Universiti Teknologi Malaysia
Prof. Ir. Dr. Abdul Wahab Mohammad	-	Timbalan Dekan Akademik, Fakulti Kejuruteraan, Universiti Kebangsaan Malaysia
Prof. Madya Dr. Zulkafli Hassan	-	Timbalan Dekan, Fakulti Kejuruteraan Kimia dan Sumber asli, Universiti Malaysia Pahang
Dr. Hj. Mohammad Omar Abdullah	-	Ketua Jabatan Kejuruteraan Kimia & Sustainabiliti Tenaga, Universiti Malaysia Sarawak

Lampiran:

Jadual 1. Pertindihan kursus dengan institusi-institusi lain

Aluan Pengerusi

Pengerusi mengalu-alukan kedatangan para jemputan daripada Institusi Pengajian Tinggi Awam Malaysia, dan beliau memberi taklimat ringkas berkenaan dengan cadangan penawaran Program Sarjana Muda Kejuruteraan Kimia, Universiti Malaysia Sarawak.

	Perkara **Agenda**	**Perkara**
1.	Pembentangan kurikulum, program Sarjana Muda Kejuruteraan Kimia dengan kepujian, UNIMAS	Pembentangan telah dibuat oleh Ketua Jabatan Kejuruteraan Kimia, UNIMAS. Berikut adalah antara perkara-perkara yang dibentangkan: (i) Kurikulum yang akan ditawarkan oleh Program Kejuruteraan Kimia, UNIMAS. (ii) Pertindihan kursus-kursus yang akan ditawarkan oleh Program Kejuruteraan Kimia, UNIMAS dengan kursus-kursus yang ditawarkan oleh institusi-institusi pengajian tinggi awam Malaysia. (iii) Bidang pengkhususan iaitu Sustanabiliti Tenaga.
2.	Maklumbalas dari para jemputan	(i) Kurikulum adalah memenuhi kehendak Lembaga Akreditasi Kejuruteraan (EAC); Program Sarjana Muda Kejuruteraan Kimia dengan kepujian UNIMAS mempunyai taburan kursus seperti berikut: • Kursus teras kejuruteraan kimia – 107 • Kursus pelengkap – 9 • Kursus generik universiti/bahasa – 14 (ii) Program yang ditawarkan mempunyai bidang pengkhususan iaitu Sustanabiliti Tenaga yang tidak ditawarkan di mana-mana IPTA (Sila rujuk Jadual 1). (iii) Kursus-kursus yang berkaitan dengan bidang pengkhususan yang telah dikenalpasti termasuk sumber tenaga dan aplikasi, polimer untuk aplikasi tenaga dan kursus-kursus elektif (Fuel cell untuk pengangkutan, Tenaga-bio, Sustanabiliti dalam industri tenaga). (Sila rujuk Jadual 1). (iv) Program yang ditawarkan adalah bersesuaian dengan kehendak industri. (v) Para jemputan yakin bahawa penawaran program Kejuruteraan Kimia, UNIMAS dapat memenuhi kehendak industri-industri yang disenaraikan oleh SCORE (termasuk industri minyak & gas asli, kelapa sawit, aluminium, kaca, perkayuan – pulp dan kertas, perikanan & akuakultur, serta industri arang batu).
3.	Hal-hal lain	Sekali lagi, wakil-wakil IPTA yang hadir bersetuju bahawa program yang ditawarkan adalah unik (Sustainabiliti Tenaga) dan tidak ditawarkan oleh IPTA-IPTA lain.

4.	Kesimpulan	Hasil mesyuarat ini telah mengesahkan bahawa program Sarjana Muda Kejuruteraan Kimia, UNIMAS, yang akan ditawarkan ini adalah unik- selari dengan industri-industri kimia/tenaga di Sarawak, dan Malaysia secara amnya.
Mesyuarat ditangguhkan pada jam 4.45 petang dengan ucapan terima kasih daripada Pengerusi.		

Minit disahkan oleh:

Prof. Madya Dr. Wan Hashim Wan Ibrahim
Dekan,
Fakulti Kejuruteraan, Universiti Malaysia Sarawak

Tarikh Disahkan: 9 May 2008

Jadual 1. Pertindihan kursus dengan institusi-institusi lain

Komponen Kursus	Pertindihan dengan Universiti Tempatan									Pertindihan dengan Universiti Luar Negara			
	UNIMAS	UTM	UKM	UMP	UTP	UMS	USM	UM	UiTM	Monash University (Australia)	University of Rochester (US)	MIT (US)	CSM (US)
Mekanik Bendalir	*	*	O	*	*	*	O	*	*	*	*	*	*
Termodinamik	*	*	*	*	*	*	*	*	*	*	*	*	*
Proses Kimia	*	O	*	O	O	*	O	*	*	O	*	O	O
Kimia Organik	*	O	*	*	*	O	*	*	O	O	O	O	*
Keseimbangan bahan & haba	*	*	O	*	*	*	*	O	*	*	*	O	*
Lukisan Kejuruteraan	*	*	O	*	*	O	*	*	O	O	O	O	O
Ekonomi Kejuruteraan	*	*	*	*	*	O	O	*	O			O	*
Proses Pengasingan & Teknologi partikel	*	*	*	O	*	*	*	*	*	*	*	*	O
Proses Pemindahan	*	*	*	O	*	O	*	*	*	*	*	*	*
Sistem Kawalan Proses	*	*	O	*	*	*	*	*	*	*	*	*	*
Kimia Analisis	*	O	*	*	O	O	*	O	O	O	O	O	O
Pemprograman Kejuruteraan	*	*	*	*	*	*	*	*	*	*	*	*	*
Imbangan Tenaga	*	*	O	O	*	*	*	O	*	*		O	*
Kejuruteraan Alam	*	O		*	O	*	*	O	O	O	*	O	

* Kursus melebihi 85% dengan nama atau kandungan kursus di UNIMAS O 40-50% serupa dengan nama atau kandungan kursus.

Sekitar													
Proses Instrumentasi	*	O	O	*	*	O	O	O	*	O	O	O	O
Kejuruteraan Bahan	*	*	*	*	*	*	*		*	*	O		O
Proses Tindakbalas Kimia	*	*	*	*	*	*	*	*	*	*	*	*	*
Operasi Unit Kimia	*	O	*	*	*	O	O	O	O	O	O	O	*
Keselamatan Pekerjaan dan Kesihatan	*	O	O	*	*	*	O	O	O			O	
Rekabentuk Projek	*	*	*	*	*	*	*	*	*	*	*	*	*
Jaminan Kualiti dan Reliabiliti	*			O		O	O						
Sumber tenaga dan aplikasi	*	O	O								*	O	
Polimer untuk aplikasi tenaga	*										O	O	O
Kursus Elektive:													
Biodiesel dan Fuel Cell untuk Pengangkutan	*		O						O	O	*		O
Kejuruteraan Rawatan Air dan Air Sisa	*	O	O	O		O					*		
Kejuruteraan Gas Asli	*	*				O	O		O				*
Tenaga-Bio	*	O				O	O		O		O		O
Sustainabiliti dalam Industri Tenaga	*		O							O	O	*	

* Kursus melebihi 85% dengan nama atau kandungan kursus di UNIMAS O 40-50% serupa dengan nama atau kandungan kursus.

.....bersambung dari Jadual 1

Lampiran L

Minit Mesyuarat Bersama Industri

Attendees

Prof. Madya Dr. Wan Hashim Wan Ibrahim	-	Dean, Faculty of Engineering, Universiti Malaysia Sarawak, (Chairman)
Dr. Hj. Mohammad Omar Abdullah	-	Head of Chemical Engineering and Energy Sustainability Department, Universiti Malaysia Sarawak
Mr. Mohd. Aris Yusof	-	General Manager, Assar Chemical Industries, Sejingkat, Kuching
Mr, Mohd Yatim Hassan	-	Manager, Human Resource Develeopment and Training, Malaysia LNG Sdn. Bhd, Bintulu, Sarawak
Mr. Mortadza bin Mohsen	-	Manager, Accacia Cellulose International Sdn. Bhd, Kuching, Sarawak
Mr. Rhyn Ng	-	Project Manager, Similajau Industries Sdn. Bhd, Kuching, Sarawak
Mr. John Reeve	-	Study Director, Rio Tinto Aluminium Limited, Kuching Sarawak
Mr. Edward Suka	-	Human Resources and Administration Manager, CMS Cement Sdn Bhd, Kuching, Sarawak
Mr. Julien Alen	-	Assistant Director, State Planning Unit, Chief Minister's Department, Sarawak
Dr. Rubiyah Baini	-	Lecturer, Faculty of Engineering, Universiti Malaysia Sarawak
Dr. Abu Salleh Ahmed	-	Lecturer, Faculty of Engineering, Universiti Malaysia Sarawak
Mr. Nazeri bin Abdul Rahman	-	Lecturer, Faculty of Engineering, Universiti Malaysia Sarawak
Ms. Norfamila Che Mat	-	Lecturer, Faculty of Engineering, Universiti Malaysia Sarawak

Enclosure:
Annex 1
Annex 2

Welcoming Remark by the Chairman
The chairman welcomes the invited guests from the industries as well as the faculty members.

	Agenda	Summary	Remark
1.	Chemical Engineering Curriculum Presentation	The proposed chemical engineering programs have been presented by the Head of Department Chemical Engineering and Energy Sustainability (ChemEs), UNIMAS.	To all attendees
2.	Ten (10) priority industries in SCORE: Responses from the invited guests from the industries about the Chemical Engineering Program.	• The program is impressive and would be able to cater the need of chemical-related industries in Sarawak and Malaysia as a whole. • Human capital output in terms of engineering graduates (especially chemical engineers to be offered) at UNIMAS is in parallel with the needs of SCORE. • The invited guests from the industries agreed with the relevancies of the mapping of the courses to the need of the prioritized industries outline by SCORE. (Please refer to **Annex 1** for detail). • The invited guests fully agreed that the intended Chemical Engineering Program should be offered to provide sufficient professional workers in the SCORE industries. • The invited guests agreed that the program should be offered in this coming 2008/2009 session. • The representatives from the industries strongly agreed that the formation of the program would be able to contribute to the need of work force required by the main industries in the SCORE as well as other chemical- and energy-related industries.	To all attendees

3.	Input from SPU: The core of the SCORE industries	• SPU suggested the importance of core industries (natural gas, coal and hydro) of the SCORE. (**Action**: : has already been embedded in the courses throughout – refer to **Annex 2** for the detail mapping of the subjects to the core industries of the SCORE)	To all attendees
4.	Environmental and Sustainability Issue	• Integration or embedding environmental and sustainability elements in Chemical engineering courses are important. (**Actions**: has already been embedded in many courses, e.g. KNC 2142 Environmental Engineering, KNC 4332 Energy & Environmental Management, KNC 4383 Sustainability in energy industry, etc.)	To all attendees
5.	Industrial training	• Industrial Training could provide exposure in real chemical engineering practice. Malaysian public universities perhaps could also consider at least six (6) months industrial training for our engineering students in future. (**Action**: will discuss in future; but requirement from EAC currently is around 10 weeks; UNIMAS practice is at least 14 weeks (1 semester) for industrial training currently, may well be extended according to needs).	To all attendees
6.	Communication skill requirements	• The local university graduates should posses high level communication ability, including presentation and report writing. (**Action**: : has already been embedded in 12 credit hours of generic subjects, including 6 credits hours from the Center for Language Studies, e.g. PBI1012 English for professional purposes, PBI1022 Creative writing in English, PBI1052 English for the real world, etc.)	To all attendees
7.	University – Chemical Industries Collaboration	• The invited guests without hesitation agreed to collaborate with the faculty of engineering on the continuous improvement of the Chemical Engineering program at UNIMAS by providing feedbacks on the industry current needs, venue for students training as well as university-industry research collaboration.	To all attendees
8.	International standards	• Internationally accepted standards in chemical engineering such as MS, ASTM, ASME, ANSI, API and etc is recommended to be adopted in all learning and teaching activities. (**Action**: : has already been embedded in the courses and laboratory test methods throughout. Lecturers and students will be advised to follow strictly the standard methods prescribed by the above bodies).	To all attendees

9.	Plant maintenance and operation course	• This course and similar good and important to be offered. (**Action**: : has already been embedded in the courses throughout)	To all attendees
10.	Elective courses	• More elective courses can be offered in the future directly related to industries of SCORE (e.g. Natural gas, Cement technology, pulp and paper processes, Aluminum processing, metallurgy and etc.) (**Action**: : KNC 4373 Natural gas engineering is already given, other courses such as cement technology, etc. can be added in near future).	To all attendees
10.	Aluminium plant related subjects	• John Reeve from Rio Tinto Aluminium Limited agreed with the offer of the Chemical Engineering program which will assists in aluminium smelting plants and that the company is in need of chemical engineers immediately.	To all attendees
The meeting adjourned at 5 p.m. with thanks from the Chairman.			

Minute Certified by:

Prof. Madya Dr. Wan Hashim Wan Ibrahim

Dean, Faculty of Engineering, Universiti Malaysia Sarawak

Date : 9 May 2008.

Annex 1

Mapping of the courses offer to the 10 priority industries outlined by SCORE
(8 of 10 related)

Industry	Offered courses			Remarks
1. Oil-based industry	KNC1013	:	Fluid Mechanics	UNIMAS graduates would be able to work in the fields of oil processing and exploration, natural gas and petrochemical product processing, waste and environmental management, energy sustainability, plant maintenance and management as well as in the research and development in other related fields.
	KNC1042	:	Introduction to heat and mass balance	
	KNC1063& KNC2133	:	Thermodynamic I & II	
	KNC2122	:	Introduction to heat and mass transfer	
	KNC2142	:	Environmental engineering	
	KNC2162& KNC3223	:	Chemical unit operation I & II	
	KNC2173	:	Transport process	
	KNC2193	:	Separation process and particle technology	
	KNC2202	:	Instrumentation process	
	KNC3233	:	Process control system	
	KNC3243	:	Chemical reactions process	
	KNC3253	:	Process design	
	KNC4294	:	Chemical plant design	
	KNC4332	:	Energy and environmental management	
	KNC4373	:	Natural gas engineering	
	KNC4383	:	Sustainability in energy industry	

Industry	Offered courses			Remarks
2. Aluminum Industries	KNC1013	:	Fluid mechanics	UNIMAS graduates would be able to participate in the field of aluminum processing, waste and environmental management and applying the sustainability in the energy management and in the research and development in other related field.
	KNC1042	:	Introduction to heat and mass balance	
	KNC1063& KNC2133	:	Thermodynamic I & II	
	KNC2122		Introduction to heat and mass transfer	
	KNC2142	:	Environmental engineering	
	KNC2173	:	Transport process	
	KNC2193	:	Separation process and particle technology	
	KNC2202	:	Instrumentation process	
	KNC2162& KNC3223	:	Chemical Unit Operation I & II	
	KNC3233	:	Process control system	
	KNC3253	:	Process design	
	KNC3243	:	Chemical reactions process	
	KNC4294	:	Chemical plant design	
	KNC4383	:	Sustainability in energy industry	
	KNC4273	:	Energy resources and application	
3. Metal-based industry including steel, nickel and zinc	KNC1013	:	Fluid mechanics	UNIMAS graduates would be able to serve in the field of metal processing, waste and environmental management, energy management and research and development in other related field.
	KNC1042	:	Introduction to heat and mass balance	
	KNC1082		Engineering material	
	KNC1063& KNC2133	:	Thermodynamic I & II	
	KNC2122	:	Introduction to heat and mass transfer	
	KNC2142	:	Environmental engineering	
	KNC2162& KNC3223	:	Chemical Unit Operation I & II	
	KNC2202	:	Instrumentation process	
	KNC3233	:	Process control system	
	KNC3243	:	Chemical reactions process	
	KNC4273	:	Energy resources and application	
	KNC4294	:	Chemical plant design	
	KNC4383	:	Sustainability in energy industry	

Industry	Offered courses			Remarks
4.Glass industry	KNC1013	:	Fluid mechanics	UNIMAS graduates would able to involve in the field of glass raw material processing, waste and environmental management, energy management and also research and development in other related field.
	KNC1082		Engineering material	
	KNC1042	:	Introduction to heat and mass balance	
	KNC1063& KNC2133	:	Thermodynamic I & II	
	KNC2122	:	Introduction to heat and mass transfer	
	KNC2173	:	Transport process	
	KNC2193	:	Separation process and particle technology	
	KNC2202	:	Instrumentation process	
	KNC2142	:	Environmental engineering	
	KNC3233	:	Process control system	
	KNC3243	:	Chemical reactions process	
	KNC4273	:	Energy resources and application	
	KNC4294	:	Chemical plant design	
	KNC4383	:	Sustainability in energy industry	
	KNC4332	:	Energy and environmental management	
5. Palm oil industry	KNC1042	:	Introduction to heat and mass balance	UNIMAS graduates would be able to serve in the field of fertilizer processing, energy management and biomass.
	KNC1063& KNC2133	:	Thermodynamic I & II	
	KNC2122	:	Introduction to heat and mass transfer	
	KNC2142	:	Environmental engineering	
	KNC2193	:	Separation process and particle technology	
	KNC2173	:	Transport process	
	KNC2202	:	Instrumentation process	
	KNC3233	:	Process control system	
	KNC3253	:	Process design	
	KNC4294	:	Chemical plant design	
	KNC4343	:	Biodiesel and fuel cell for transportation	
	KNC4353	:	Bio-energy	
	KNC4273	:	Energy resources and application	
	KNC4383	:	Sustainability in energy industry	

Industry	Offered courses			Remarks
6. Timber-based industry including pulp and paper	KNC1082	:	Engineering material	UNIMAS graduates would be able to work in the sector of timber-based processing, energy management, biomass, industrial waste management, and research and development for pulp and paper.
	KNC1042	:	Introduction to heat and mass balance	
	KNC2142	:	Environmental engineering	
	KNC1063	:	Thermodynamic	
	KNC2202	:	Instrumentation process	
	KNC3233	:	Process control system	
7. Livestock industry	KNC2142	:	Environmental engineering	UNIMAS graduates would be able to serve in the field of energy management, food processing, wastewater treatment and fertilizer processing.
	KNC2112	:	Analytical chemistry	
	KNC1052	:	Organic chemistry	
	KNC2173	:	Transport process	
	KNC2193	:	Separation process and particle technology	
	KNC2202	:	Instrumentation process	
	KNC3233	:	Process control system	
	KNC3243	:	Chemical reactions process	
	KNC3253	:	Process design	
	KNC4383	:	Sustainability in energy industry	
	KNC1082	:	Engineering material	
8. Fishing and aquaculture industry	KNC2142	:	Environmental engineering	UNIMAS graduates would be able to participate in the waste management, food processing, fertilizer processing, energy management and research and development of the new product.
	KNC2112	:	Analytical chemistry	
	KNC1052	:	Organic chemistry	
	KNC2173	:	Transport process	
	KNC2193	:	Separation process and particle technology	
	KNC2202	:	Instrumentation process	
	KNC3233	:	Process control system	
	KNC3243	:	Chemical reactions process	
	KNC3253	:	Process design	
	KNC4383	:	Sustainability in energy industry	
	KNC1082	:	Engineering material	

Annex 2

Mapping of the courses offer to the 3 "core" industries outlined by SCORE (2 of 3 related)
In addition, the syllabus could also assist in the Core areas of the SCORE (2 of 3 related)

Core of SCORE	Offered courses		
Coal	KNC1013	:	Fluid mechanics
	KNC1042	:	Introduction to heat and mass balance
	KNC1063& KNC2133	:	Thermodynamic I & II
	KNC2122		Introduction to heat and mass transfer
	KNC2142	:	Environmental engineering
	KNC2193	:	Separation process and particle technology
	KNC2202	:	Instrumentation process
	KNC3233	:	Process control system
	KNC3253	:	Process design
	KNC3243	:	Chemical reactions process
	KNC4383	:	Sustainability in energy industry
	KNC4273	:	Energy resources and application
Natural gas	KNC1013	:	Fluid mechanics
	KNC1042	:	Introduction to heat and mass balance
	KNC4373	:	Natural gas engineering
	KNC1063& KNC2133	:	Thermodynamic I & II
	KNC2122	:	Introduction to heat and mass transfer
	KNC2142	:	Environmental engineering
	KNC2162& KNC3223	:	Chemical Unit Operation I & II
	KNC2202	:	Instrumentation process
	KNC3233	:	Process control system
	KNC3243	:	Chemical reactions process
	KNC4273	:	Energy resources and application
	KNC4294	:	Chemical plant design
	KNC4383	:	Sustainability in energy industry